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Synaesthesia: Opinions and Perspectives

30 Interviews with Leading Scientists, Artists and Synaesthetes

Anton V. Sidoroff-Dorso, Sean A. Day, and Jörg Jewanski (Eds.)

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Contents

Foreword & Acknowledgements

Foreword

This book is a collection of interviews with the world's leading experts, artists, and public figures whose scientific research, creative aspiration, or perception are connected with natural or congenital synaesthesia (another, less accurate, name for this phenomenon). Conceived as an accessible "introduction to the topic", the original Russian version of this book was published by the Moscow State University of Psychology and Education (MSUPE); that book became the first case where natural synaesthesia was the central and single topic of a scientific publication in Russian. Its publication was devised as a forerunner of the scientific symposium in the framework of the *II International Synaesthesia Conference of the International Association of Synaesthetes, Artists, and Scientists* (IASAS), *Synaesthesia: Cross-Sensory Aspects of Cognition across Science and Art*, which was held in Moscow, October 17–20, 2019. The co-organisers of the symposium were the Moscow State University of Psychology and Education, the International Association of Synaesthetes, Artists, and Scientists, and the Moscow State Tchaikovsky Conservatory. The book on hand is a revised and extended version of the original Russian one.

One of the main purposes of the original Russian version of this volume was to introduce Russians attending the Moscow synesthesia conference, which took place the 17th–20th of October, 2019, with some of the latest "foreign" viewpoints and research regarding synaesthesia; that book was made available to all attending the conference from its first, opening day. But it was our overarching view, and hope, from the beginning, that this book would eventually serve a much broader purpose by far. We did not want to create a "one-way street", but, rather, help towards initiating and promoting—if only in a small, humble way—a vast network of mutual and balanced interchange amongst all of the different contributors and readers from all around the world.

Today's research into synaesthesia has demonstrated that the investigative inquiry of the phenomenon encompasses a wide scope

of interdisciplinary issues of scientific theory, research and practical applicability. Research into synaesthesia sheds new light on the mechanisms of brain activities as well as their environmental and genetic determinants, specifically, when seeking answers about the nature of language, imagery, metaphor and creativity. The conceptual tenets of arts education and methodological approaches to developing performative mastery are extensively derived from understanding the synaesthetic mechanisms and regularities of interconnection among several sensory modalities. Therefore, by integrating a wide array of converging lines between systematised scientific knowledge and research as well as teaching practices and creativity, the phenomenon of synaesthesia holds an immense potential for reciprocally beneficial exchange between science and art.

The world scientific community is very much aware of the value of past and current Russian research in Psychology, Neuroscience, and related fields; and realizes that, due to language barriers and other causes, much of this work remains unknown outside of Russia. We hope, through our joint efforts, the conference and ensuing events will help in rectifying that. Collaboratively, we are intending to discuss the issues of synaesthesia and present the latest results of its research in science, art and education. The cultural section of the conference was planned to include screenings of videos, exhibitions by synaesthete artists, and workshops with the blend of music and electronics.

Initially, the main idea of the book was to present to the Russian-speaking reader the broadest possible range of opinions and facts about congenital synaesthesia on behalf of the widest possible circle of specialists. However, without abandoning the early mission of the collection, we came to a more comprehensive project while composing the book. As the attentive reader will quickly notice, many of the propositions, views, and even facts put forward by our interlocutors are polemical in nature. To emphasize and also sharpen the controversial content of our collection, it was decided to make the most controversial and contrasting provisions in the form of a quote in the title of each interview. It so happened—and in this, we see a real indication of the current extant problems of research on the phenomenon

of synaesthesia — that the book, planned as an accessible introduction, as if by itself began to acquire the format of correspondence dialogue.

The selection of experts invited as interlocutors for the interviews collected in this book was carried out strictly based upon the great importance of their research and educational contributions to the field of synaesthesia of natural development. The criterion for the selection of participants from Russia was their representation in the public space of science and art. With our questions, we sought to make our book accessible and relevant. As we worked on this book, we were proud to discover that almost all specialists, artists, and scientists immediately accepted our invitation with genuine willingness, worked punctually on response comments, conscientiously criticized, supplemented some of the questions, and even corrected the underlying inaccuracies and biases.

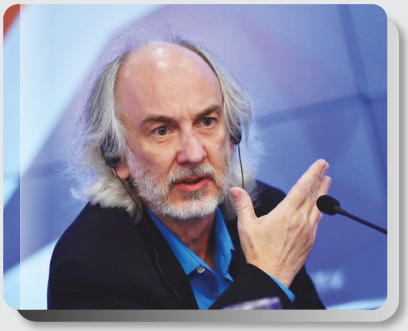
We used two simple principles as the bases of two large blocks of interviews, with the historical sketch by Jörg Jewanski as the watershed between. First, the selection of interlocutors in the first block tends to the sphere of science, mainly to psychology and other areas of research (e.g., psychophysics, psychophysiology) of the human psyche and its biological substrate, the brain. The second block is artistic, creative, personal. Not all interlocutors whose responses were placed in this part of our book are involved in art or studying arts. Still, they all have synaesthesia, which is why we dared to ask all of them, without exception, very individual questions about this phenomenon: the role of synaesthesia, about first memories associated with synaesthesia difficulties, etc.

Secondly, the interview questions were compiled and asked in two stages. The first stage for each participant included a selection of topics of universal content (the first 6 questions in the collection in the block of science and the first 7 in the artistic part), obtained from analyses of recent research publications and popular scientific articles, and generalization of the problems of discussions at symposia and conferences on synaesthesia. The second stage involved a more thorough understanding of the range of problems, research or creative methods and individual activities of each interlocutor, the

The cover of the Russian edition of the book of interviews published prior to the IASAS Moscow Synaesthesia Symposium 2019.
Published by Moscow State University of Psychology and Education (MSUPE)

history of their participation in social events, special achievements, key developments and concepts in the field of synaesthesia. Thus, starting from the above-described structure of the book, we can offer the reader a unique strategy of reading: parallel acquaintance with the answers to the first half of the questions in each of the two blocks. By comparing the sometimes vastly different, occasionally complimentary opinions of our interlocutors on similar questions, the reader will be able to get a comprehensive picture of both the generally accepted facts in the study of synaesthesia, and still open questions in this area.

This book is also unique because its appearance marks an important step of multifaceted, interdisciplinary cooperation in the research of synaesthesia in many directions at once and with the involvement of a large number of specialists. Our publication, as well as the Moscow Symposium, involved artists and scientists, authors with synaesthesia and non-synaesthetes. It introduced a scientific perspective in the face of the university and recognition from the art represented by the Conservatory. Our interlocutors are representatives of different countries and different areas of research, from



Sean A. Day

President of the International Association of Synaesthetes, Artists, and Scientists (IASAS)

holds an M.A. in Anthropology, and a Ph.D. in Linguistics. He is the founder and moderator of the Synesthesia List, begun in 1992. In 2016, he helped form the International Association of Synaesthetes, Artists, and Scientists (IASAS), and serves as its President. A multiple synaesthete himself, he has given talks about synaesthesia in numerous different forums, and has been featured in documentaries on synaesthesia around the world.

Anton V. Sidoroff-Dorso

co-founder of the IASAS, member of the IASAS Board,

International Coordinator of the IASAS II International Conference on Synaesthesia

received a specialist degree in linguistics and language acquisition and a post-graduation degree in psychology focusing on individual differences and synaesthesia. He founded the Russian Synaesthesia Community and manages its website synaesthesia.ru and database. He translated and stewards the Russian version of the Synesthesia Battery (synesthete.org). He is developing the notion and measure of Synaesthesia Quotient (SynQ).

psychology to art criticism, from pedagogy to artistic creativity. Thus, the answers to the questions that we have tried to raise in this book are not only of scientific and research importance but also personal, social, and often ideological.

Due to the novelty of its subject, and due to the accessibility, informality of its presentation, and "conversational" style in the form of questions and answers, our book will be useful to all interested in the phenomenon of congenital synaesthesia. During the invitation of interlocutors, in the process of working on the wording of questions and the expected content of the answers to our readers, we presented ourselves as people whose activities and interests do not have close ties with science (e.g., artists, musicians, designers), as well as students, beginning researchers and professional specialists (e.g., psychologists, neurophysiologists, art historians) who want to get an idea about the field of synaesthesia research in the format of a concise volume.

Acknowledgements

We would like to express our sincere gratitude to the President of the Moscow State University of Psychology and Education, academician of the Russian Academy of Education, Doctor of Psychology, Professor Vitaly V. Rubtsov. It was with Rubtsov's approval and active participation that the active stage in the preparation of the international scientific symposium "Synaesthesia: Cross-sensory Aspects of Cognition across Science and Art" began. With the support of MSUPE, our project for the symposium received funding from the Russian Foundation for Fundamental Research based on the results of the competition for best projects for organizing scientific events held in March-December 2019 in the Russian Federation (Humanitarian and Social Sciences).

Additional funding support for the Moscow 2019 conference was generously given by many others, including the George Sarlo Foundation, Paul Eggert, and Christa Lewis. We are extremely grateful for this help.

We would also like to thank the acting Rector of the Moscow State University of Psychology and Education, Candidate of Psychological Sciences, Professor Arkady Aronovich Margolis, and the Head of the Center for Interdisciplinary Studies of Modern Childhood at MSUPE, Associate Professor of the Faculty of Education at MSUPE, Candidate of Psychological Sciences Olga Vitalievna Rubtsova. In 2018, in order to study the mechanisms of the development of synaesthesia in children with a genetic predisposition to this phenomenon, and to develop methods for the study and development of individual psychological characteristics related to synaesthesia, a research group, Synaesthesia: Children and Parents, was created on bases set by the Center for the Management of Humanitarian Problems of the Moscow State University of Psychology and Education and the IASAS. We highly appreciate the leading role of the Moscow State University of Psychology and Education in organizing research and popularizing knowledge about congenital synaesthesia in Russia.

The International Association of Synaesthetes, Artists, and Scientists is eager to express special gratitude for support and kind words to the Merited Art Worker of the Russian Federation, Chairman of the International Union of Musical Statesmen, Rector of the Moscow State Tchaikovsky Conservatory, Doctor of Arts, Professor Alexander Sergeevich Sokolov. Collaboration with the Conservatory in organising the symposium on synaesthesia was a great honour for all the participants of the symposium and opened up new frontiers for productive and mutually beneficial cooperation between art and science.

For effective business interaction, responsiveness and a flexible approach to organizing the symposium within the walls of the Conservatory, we would like to thank the Vice-Rector for Scientific Work of the Moscow State Tchaikovsky Conservatory, Doctor of Arts, Professor Konstantin Vladimirovich Zenkin. We also express our gratitude to the Assistant Professor of the Department of the History of Foreign Music and the Department of Humanities, a senior researcher at the Research Center for Methodology of Historical Musicology at the Moscow State Tchaikovsky Conservatory, Candidate of Arts Theory Elena Vladimirovna Rovenko. Thank you for your initiative, dialogue and inspiration.

We thank the Head of the International Relations Department of the Moscow State University of Psychology and Education, Natalia Andreevna Baykovskaya, and the department's specialists, Elena Vyacheslavovna Bashkirova and Shushanik Araevna Usubyan. Only due to the high standards of work from the department and their volunteers, organized by Baykovskaya with unprecedented effectiveness, did the Moscow symposium receive a well-coordinated mechanism for conducting a productive working environment.

We are absolutely certain that this book would not have been released without the focused, disciplined and creative work of our team of translators distributed around the world, whose work, due to the novelty of the topic and the lack of a sufficient number of Russian-language reference texts on synaesthesia, required not only knowledge in psychology and art, linguistic insight and first-hand

understanding of synaesthesia, but also genuine curiosity and diligent research. Translators uncompromisingly worked on the interview texts: Sofya Vtornikova, Elena Lastovina, Anastasia Malyshevskaya, Lilia Mubarakshina, Dmitry Nedil'ko, Natalia Ovcharenko, Fyodor Paligin, Rustem Sakhabiev, Alexandra Serova, Sofya Sklyarova, Anna Khismatullina, Alexandra Chepanova. Friends, the International Association of Synaesthetes, Artists and Scientists thanks each of you personally.

The organizers also thank Polina Varlashkina for her innovative, creative approach and focused attitude to the project to develop a visual style of printed materials accompanying the IASAS Moscow Symposium on synaesthesia.

It is necessary to mention separately that not only we, the editors, but also those interviewed themselves took part in the preparation of questions for our book, adding, emphasizing or correcting some formulations of our questions (especially for the second, "individual" stage). Also, a virtual forum of the Russian synaesthete community in one of the social networks served as a special source of questions for us. An upcoming book was announced among the participants and a request was circulated to propose questions to experts. Several topics were selected that we included, sometimes with some clarifications, in the block of individual questions for this or that expert in accordance with the subject of his or her research or creativity. As was announced in the request, the names of authors of the questions are mentioned in the wording of these questions in our book.

We sincerely thank all our interviewees that they readily accepted our invitations, were patient with the discussions of the proposed questions and provided timely answers and comments.

Unlike books and traditional monographs, work on a publication of this kind — selecting those to be interviewed, compiling relevant, substantive issues, coordinating, translating and editing — requires incomparably more time, focus and effort. Not without a sense of awkwardness, the editors thank their near and dear ones for the attention, dedication and care that they, often unrequitedly, showed to us in the protracted moments of our "creative rapture".

We hope that this book will reach the widest possible audience, will be useful to all our readers and will be a worthy result of a great deal of work. We thank our readers for the fact that our book came into your hands, and for your attention and interest in the topic of synaesthesia.

Anton V. Sidoroff-Dorso, Moscow, Russia
Sean A. Day, Charleston, South Carolina, USA
Jörg Jewanski, Vienna, Austria

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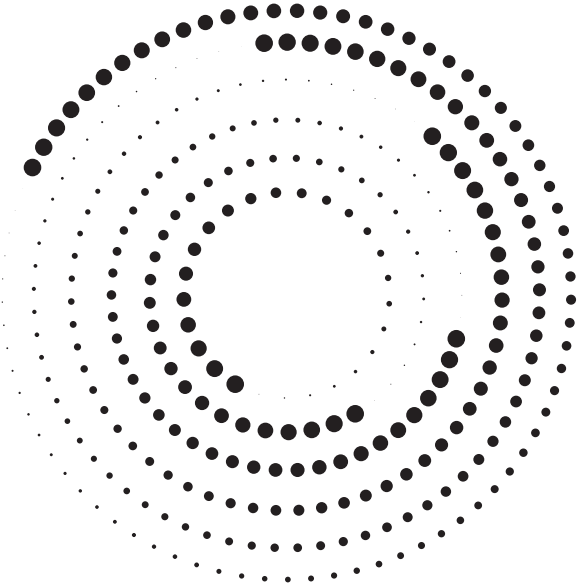
Synaesthesia research today



Synaesthesia research today

What is synaesthesia?

One of the many examples of innate synaesthesia — and we will start our definition with examples so that the reader will immediately understand what exactly we are talking about — is manifested in non-arbitrarily arising sensations of colour shades and other sensory qualities in the perception of letters or numbers. In other words, in the consciousness of a person with synaesthesia of natural development, a colourless letter or number is always endowed with one or more unique, stable colours, sometimes with texture, luminosity, saturation, and other characteristics. According to data collected by one of the authors of this editor's preface (Day, 2016), this is the most common type of synaesthesia in the world. According to the unpublished data of another editor (Anton V. Sidoroff-Dorso), the most common manifestation of synaesthesia of natural development in Russia is so-called "colour hearing", congenital synaesthesia manifested in the fact that listening, creating or merely thinking through musical fragments is accompanied by a subjective feeling of non-objective colour impressions.

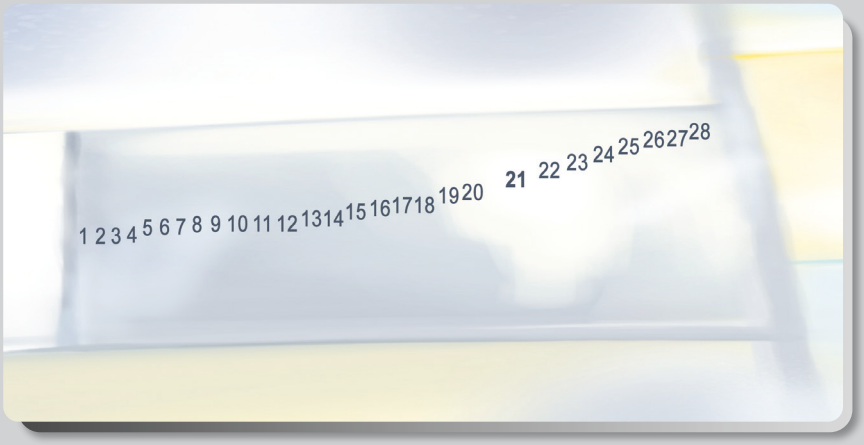
A reaction of congenital synaesthesia is perceived as an automatic, involuntary response to a specific stimulus in the form of an unusual additional sensation. This is the difference between synaesthesia of natural development and culturally conditioned associative relationships, cross-modal imagery, sensory standards generated through lived experience, learning, and personal choice. For example, in a particular cultural community, a caramel, artificially coloured green, can be subjectively associated with the taste of apple or lime. However, if you, as a representative of this community, find yourself in a different cultural context for a long time, the green can easily acquire a connection with cucumber, cherimoya, or another new taste. You may find or decide that the number 102 is on your right and a little higher — say, an apartment with such a number is located in this direction. Although changing a residence may result in a quick change in

the number and location. Congenital synaesthesia is different: the reactions are not based on memory and imagination; therefore, they do not assume a choice and do not depend on purposeful change. If, thanks to congenital synaesthesia, the taste of some food (for example, the taste and aroma of coffee) causes a person with congenital synaesthesia to feel an ultramarine flare, then this taste will forever be associated with this colour and shape, whether she or he likes it or not.

In scientific terminology, the formula "stimulus-response" is used to describe the types (varieties) of synaesthesia of natural development. For instance, the addition of perception of colours when seeing or thinking about non- or differently-coloured letters (e.g., printed in black) is called grapheme-colour synaesthesia. Some studies classify types of synaesthesia as several large groups. For example, lexical-colour types include letters, words, and names as stimuli (this also includes grapheme synaesthesia). Music-colour ("colour hearing") and grapheme-colour synaesthesia are probably some of the hundreds of varieties of congenital synaesthesia. What exactly will become synaesthetic stimuli and what particular sensory quality (or several qualities) will be an accompanying experience is not clear in each case (Cytowic & Eagleman, 2009; Simner, 2012; Day, 2016).

Due to the unique nature of the connections of stimuli and reactions in synaesthesia of natural development, if the sound of a saxophone, the letter "M" or the note "C" causes a feeling of a specific colour, or the word "gyroscope" provokes a particular taste and a sense of texture of food, it does not mean that another synaesthete with the same kind of phenomenon regarding the same stimuli in the form of additional experiences will display qualitatively identical sensory properties. Moreover, reactions can manifest experiences that, due to their cognitive complexity, can hardly be attributed to the sensory elements of subjective experience. Among other things, in some types of synaesthesia, special touches generate emotional reactions not typical in everyday life. The perception of calendar years can take the form of a line extending in subjective space, often in unexpected directions: non-symmetrical zigzags, irregular circles, etc. (localization sequences) (see, for example,

Artist, architect and designer Anna Inozemtceva's synaesthetic colour, luminence and spatial experience of the category of months. The multiple frames in the lower part of the picture are how Anna perceives a line of several "joint" years. Created by Anna Inozemtceva



Artist, architect and designer Anna Inozemtceva's synaesthetic colour, luminence and spatial experience of the days of the month Fabruary. The white spot around "21" is Anna's birthday. Created by Anna Inozemtceva

Price, 2009). Numbers can inexplicably be endowed with the properties of human personality (personification) (Amin et al., 2011).

The synaesthetic connection is formed at the earliest (natal, and perhaps, perinatal in some cases) stage of ontogenetic development, before the stable autobiographical memory. Thus, the subjective manifestations of this phenomenon are integral, natural, not perceived as an individual feature aspect of the cognitive activity of the synaesthete subject. Moreover, the mechanisms of its initial appearance cannot adequately be placed as solely due to the memory and reflection of its carrier. In some cases, synaesthetic reactions may remain unnoticed for a long time by their carrier due to the absence of social issues (cases of influence of "sensory socialization") when the existing synaesthetic features reveal their presence communicatively or functionally. Often, synaesthesia does not just cause confidence about perceiving reality "here and now"—this question is not even raised because of the habit, the ordinariness of synaesthetic reactions for the synaesthete, their consistent inclusion in the canvas of perception. Sometimes, synaesthetic sensations can be elusive and hard to describe, as for this kind of identification, it is challenging tofind the exact expressive means of language, to point to the equivalent in the external world and/or to direct the mechanisms of reflexive attention to them. If consciousness understands the synaesthetic reactions, they are perceived by people with synaesthesia as a result of the functioning of their thinking (brain, mind, etc.) (Kravkov, 1948).

These qualities of additional sensory characteristics that appear in synaesthesia of natural development, coupled with the systematized selectivity of synaesthetic reactions, their orientation to a specific type of cognitive or creative activity or "category of experience", and the adequacy of the attribution of the mechanisms of experience, distinguish this phenomenon from other subjectively manifested involuntarily arising phenomena, both pathological and intoxicating (e.g., hallucinations, hyperesthesia) and neurotypical (e.g., illusions, afterimages, associations). The instrument and laboratory studies of synaesthesia convincingly excluded this phenomenon from several phenomena of hyper-imagination, anomalies, and hyperreactivity of memory

and other cognitive processes with an accentuated degree of manifestation (see, for example, Hubbard & Ramachandran, 2005; Sagiv et al., 2011). It is equally important that, according to the conclusion of the researchers, confirmed by statistics, people with natural synaesthesia do not exhibit any mental abnormalities (Luria, 2006; Kravkov, 1948; Cytowic, 2002).

An essential fact about congenital synaesthesia is that synaesthetic reactions do not replace one type of perception with another. If you see colour in response to sound, it does not mean that something is wrong with your hearing. Nor is synaesthesia a mystical superpower. Thus, if a synaesthete perceives music as coloured visual reactions, he or she does not see the physical colour of sounds. The most straightforward ideas about the physical world tell us that sounds do not and cannot have colour. Nevertheless, it seems that the brain of the musical-colour synaesthete adds colour reactions in response to the perception of musical sounds. This perception does happen on the inner, subjective level, yet it is not a direct perception of external, physical reality. Thus, if the additional nature of synaesthetic reactions carries specific information, it is not about the external, physical reality, but the subjective manifestations of the structural and functional features of the neurophysiology of the synaesthete brain.

From the point of view of scientific psychology, some might find congenital synaesthesia to be a phenomenon of a marginal order or even a term from the dictionary of parapsychologists and other pseudoscientific fields. However, at this time, congenital synaesthesia has established itself as a full object of research in the world of psychological science. Since the 2000s, the leading scientific journals (e.g., *Nature Neuroscience*, *Cognitive Neuroscience*, *Attention*, *Perception and Psychophysics*, *Frontiers in Human Neuroscience*, *Multisensory Research*) regularly publish works on psychological, psychophysical, neurophysiological, demographic, and molecular genetic studies of synaesthesia. During the same period, at least 10 monographs and manuals were published on synaesthesia of natural development, including the fundamental edition of the *Oxford Handbook*

of Synesthesia, edited by Julia Simner and Edward M. Hubbard (2013; see also Sagiv & Robertson, 2005; Baron-Cohen & Harrison, 1996).

Why study synaesthesia?

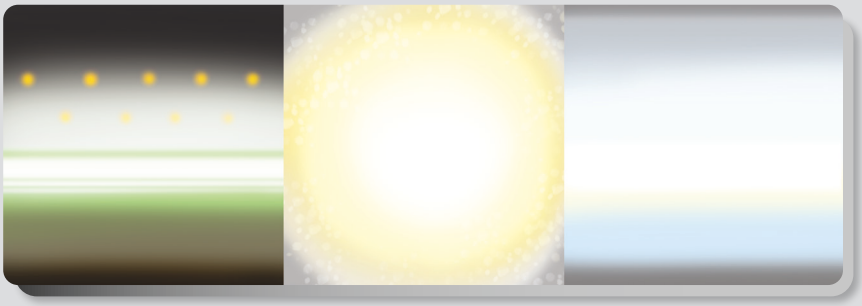
Oliver Sacks, the famous American neurologist and writer, says in his review of *Wednesday is indigo blue*, by Richard E. Cytowic and David M. Eagleman (Cytowic & Eagleman, 2009), one of the books on congenital synaesthesia: "Twenty years ago, synesthesia [US spelling] — the non-arbitrary fusion of two or more sensory systems — was viewed by scientists (if at all) as a kind of rare gimmick. Today, we know that probably one in twenty of us has synesthesia, and therefore we must recognize synesthesia as an integral and surprising part of subjective human experience. Moreover, synesthesia can be the basis and stimulus of figurative and metaphorical thinking of a person." Synaesthesia often appears on the pages of popular scientific works of Sacks himself: *Musicophilia* (Chapter 14, *The Key of Clear Green: Synesthesia and Music*), *An Anthropologist on Mars* (*The Case of the Colorblind Painter*), and other works.

Authoritative experts of neurocognitive research also recognize the importance of studies on synaesthesia of natural development. Bernard Baars and Nicole Gage, in the textbook *Brain, cognition, mind: Introduction to cognitive neuroscience*, state that

> "understanding the genetic basis of synaesthesia contributes to understanding how communication in the brain is usually provided. The phenomenon of synesthesia shows that more than one type of brain and one type of thinking are possible. Synaesthesia is present in one in several hundred people, making it much more common than it is believed, and much more critical scientifically than mere curiosity".
>
> (Baars & Gage, 2014, p. 221–222)

American neurophysiologist Vilayanur S. Ramachandran makes an even more promising conclusion about congenital synaesthesia:

> "…this bizarre little phenomenon sheds light on the normal method of processing sensory information, but also shows a winding road



Artist, architect and designer Anna Inozemtceva's synaesthetic perception of music pieces. From left to right: *Imagine* by John Lennon, *Karmacoma* by Massive Attack, *Girl with the Flaxen Hair* by Claude Debussy. Created by Anna Inozemtceva

> leading to the most mysterious aspects of our consciousness, such as abstract and metaphorical thinking. Synesthesia can shed light on what features of the structure of the human brain and genetic features underlie important aspects of creativity and imagination".
>
> (Ramachandran, 2016, p. 90)

Today, synaesthesia of natural development is studied in an attempt to raise new questions about psychogenetic patterns, systemic mechanisms of the brain and significant features of its structure, the nature of natural language and creative thinking, creative abilities, their relationships with individual elements of perception, and personality-typological properties. This research has already contributed to the development of scientific knowledge about genetics, psychology, and psychophysiology of humans. For example, it has been demonstrated that genetic markers of congenital synaesthesia are associated with genes responsible for general human language abilities, mechanisms of brain plasticity, and neurogenesis (Asher et al., 2006; Tomson et al., 2011; Tilot et al., 2018). Based on the mechanisms revealed by the example of synaesthesia, the number of successful cases of ridding patients of the illusions of phantom limbs increased to 60% (for

example, Fiodorenko-Dumas et al., 2015). Technologies developed on the bases of ideas about synaesthetic mechanisms of interaction with the environment have also been used in the construction of prostheses, sampling and data collection systems (e.g., NASA), navigation devices, comprising the resources of the US Army and Navy, the US and Canada police. Naturally, synaesthesia is now becoming part of developments to improve "deep learning", multisensory pattern recognition, and other artificial intelligence algorithms (e.g., Aytar et al., 2016; Bock, 2018).

What causes synaesthesia?

From a more strict scientific standpoint, synaesthesia of natural development can be defined as a neurophysiologically conditioned, individual feature of perceptual response, which means that the perception of a stimulus belonging to a specific category of experience, in the subjective plan (endogenous), is accompanied by the experience of additional sensory, perceptual or cognitive characteristics that are not inherent in the perception of this phenomenon (stimulus) as statistically expected physical properties, the results of the mechanisms of perception or inference. The origin of synaesthetic connections between stimuli and reactions is unmotivated; that is, they cannot be explained by ordinary associations generated by experience, purposeful learning, and spontaneous influence of the environment. The manifestation of synaesthetic experiences is, however, characterized by strict order of relations between the category of stimuli and the system of reactions, involuntary provocation, and, in the overwhelming majority of individual cases, qualitative immutability throughout life. An exception in this sense can be a change in the intensity of experiences, up to complete disappearance by a certain age.

The genetic determinants of synaesthesia have repeatedly received significant scientific evidence both through the study of families (close relatives, siblings, including twins) (see, for example, Baron-Cohen et al., 1996), and as a result of molecular genetic studies (Asher et al., 2006; Tomson et al., 2011; Tilot et al., 2018; see also Brang & Ramachandran, 2011). Nevertheless, the explanation of synaesthesia solely by

Multiple synaesthete Ivan Belov's experience of colour and gender in response to perceiving numbers, Cyrillic, Latin and Greek letters, names of the months, basic geometric shapes and colours. The underscore indicates the gender: Blue stands for masculine, red for feminine. Some letters can change colours in different context. For example, the letter S is blue but if it denotes a subdominant in music, it is perceived as red. When being part of the symbol for a chemical element, it is green. Created by Ivan Belov

hereditary mechanisms faces an apparent contradiction (cf., Brang & Ramachandran, 2011). Analyses of the cases from type to type revealed that the stimuli that cause synaesthesia are categorical. That is, specific stimuli reflect the events of reality, ordered by an individual, in the form of categories conditioned by experience, meaningfully consisting of the cognitive activity mediated by them (e.g., "natural" and purposeful feeling of the flow of time, culturally mastering a system of time reckoning, the sensual impression of quality and mediated understanding of numbers, "natural" noise and "conceptual" music). In some types of synaesthesia, the content of the stimuli may include all the stimuli of

one modality; that is, have a "solid" character (for example, all sounds; in other words, the entire audible "substrate"). Intermediate in cognitive complexity, categorical systems of stimuli differ in key character. In some cases, they can have more abstract, symbolical value; for example, names of people, or the name of days of the week and months.

Regarding the genetic determination of synaesthesia, studies in families revealed the contribution of genetic factors in the development of this trait. The particular role of common genomic variations to synaesthesia has been investigated with the largest genotyped collection of unrelated people with grapheme colour synaesthesia, SynGenes cohort (n = 723). Based on previous literature on overlaps of presumed traits, polygenic indicators were obtained from published genome-wide scans of schizophrenia and autism spectrum disorders (ASD) and investigated, comparing the SynGenes cohort with 2,181 non-synesthetic controls. It was discovered that there is a very weak relationship between indicators of schizophrenic polygenic scores and synaesthesia, and no significant relationship between the scores associated with ASD or body mass index included as a negative control (Tilot et al., 2019).

In all types of synaesthesia of natural development, synaesthetic reactions find constant, involuntary and invariable expression in the fact that additional sensory qualities selectively accompany the perception of systemically organized phenomena of reality, creating (individually in each case) a specific area of human activity, a cognitively structured sphere; that is, a broad "category of experience". For example, listening, the use of music, the recognition of letters, the experience of emotions, the idea of the flow and units of time, or the topologized perception of human appearance. In the sensory sphere of people with synaesthesia, the sensory mode of experience, which is not conditioned by the physical properties of perceived objects, is included as an additional component in the perception or "thinking" of certain categorized constituent elements, e.g., speech sounds, tones (or their graphic display in the form of letters and notes), and in the implementation of specific cognitive activity, mediated by these elements, e.g., playing music, reading and writing, counting, timing (Cytowic & Eagleman, 2009; Simner, 2012; Day, 2016; Sidoroff-Dorso, 2013a).

So, nearly all stimuli of synaesthesia are systems that mediate a specific function in the subjective experience of a person, such as reading, musical expressiveness, mathematics, and social cognition. These so-called broad "categories of experience" do not have specific genetic methods of inheritance, and are transmitted from generation to generation only as psychophysiological mechanisms underlying the most general abilities of humans as a biological species. For example, a person does not inherit a specific language (or, especially, a written system), which, in particular, is used for his or her social interactions with others, and not even the ability for verbal communication; rather, the ability to create, mediate and transmit meanings, materializing them in any available "instrumental" way, gets passed on through genetic mechanisms.

Therefore, the features of the influence of the environment, the external conditions of development of specific human abilities to read and write, speech, language, social cognition, and mathematics are as crucial for understanding the phenomenon of synaesthesia of natural development as genetic and epigenetic factors. The complex cognitive content of synaesthesized stimuli, their organization around specific types of cognitive activity strategies, which are based on cultural and environmental determinants, does not allow to define synaesthesia of natural development in the "nativism" style as an innate psychophysiological property. The apparent environmental influence, although not as obvious as in the formation of cognitive skills, stereotyped response patterns or individual associativity, places synaesthesia in a special position with respect to both the understanding of empirically demonstrated heredity and learning and experience, or at least to the minimally structuring process of adaptive interaction of the organism with the environment (see, for example, Watson, 1997).

Moreover, although the phenomenon under consideration irrefutably shows signs of heritability and genetic predisposition, the manifestation in the psychophenotype of this property of perception does not occur with absolute regularity. For the two reasons mentioned, concerning synaesthesia of natural development, the

term "innate" should be used with a detailed conditionality. That is why we use the compound term synaesthesia of natural development with much greater confidence in the accuracy of the phenomenon's definition, and with some degree of caution refer to the specific combination of congenital synaesthesia.

How do we determine synaesthesia?

Standardized tests are used to varying degrees to verify the manifestations of synaesthesia. For example, the so-called consistency test (retest), which, in the case of additional experiences of colour, is based on the use of coupling of reactions with samples from a colour palette. The accuracy, speed, and some identical responses — both provided by the subject directly during a single session, and reproduced by them after a significant period, sometimes solicited suddenly — are the indicators of the genuineness of synaesthesia. So, the Test of Genuineness Revised (TOG-R) theory allows working with any type of synaesthesia with a sensory response in the form of colour (Asher et al., 2006). Also, researchers have access to the online Synesthesia Battery test with functionally identical software for personal computers on the MATLAB platform. The online program and the version for PCs are equipped with an archive for working with individual and group cases (Eagleman et al., 2007). An unauthorized, but equally functional "mobile" version (without Russian language support) is available for devices on the Android platform.

Interference or facilitation tests, exploring results of synaesthetic reactions, are also used in studies of synaesthesia; for example, specially designed synaesthetic Stroop tests, experimental procedures based on the priming effect, and visual search matrices (Wollen & Ruggeiro, 1983; Radvansky et al., 2011). In the first two types of empirical research, the subjective experience of synaesthetic reactions receives objective confirmation on the basis of a negative effect, the interference (delayed execution of tasks, increased reaction time).

In the third type of tests, on the contrary, synaesthetes demonstrate a facilitating effect; that is, more effective performance of tasks. At the same time, in subjective terms, due to the synaesthetic reaction,

subjects quickly detect the necessary elements among visually similar elements-distractors. It manifests itself as a non-arbitrary visual selection (pop-out effect) or grouping of individual items (letters/numbers) in the visual field.

Neuroimaging via functional magnetic resonance imaging (fMRI) helped to record the unusual local brain activity of synaesthetes within the fusiform gyrus and the areas of the primary visual cortex V1/V4 (Ramachandran & Hubbard, 2001). The neuroimaging fMRI studies demonstrated that specific brain areas are activated in subjects with synaesthesia (Nunn et al., 2002; Weiss et al., 2001). With the help of DTV (diffuse-tensor visualization) and TMS (transcranial magnetic stimulation), structural and functional (at the moment of stimulus-reaction experience) features of synaesthetic brain functioning were revealed (see, for example, Rouw & Scholte, 2010; Terhune et al., 2011).

Three models of psychophysiological mechanisms of synaesthesia have been proposed for individuals with synaesthesia: cross-activation (Ramachandran & Hubbard, 2001; Ramachandran & Hubbard, 2003), disinhibited feedback (Grossenbacher & Lovelace, 2001), and reentrant processing (Smilek et al., 2002). To date, however, neuroimaging has not been able to reliably prove or deny any of the proposed theoretical models of synaesthesia. Moreover, a large-scale analysis of the results of numerous studies has called into question the possibility of the study of the structural differences and functional laws common to all individual cases of synaesthesia in comparison with the same characteristics in people without synaesthetic perceptual features (Hupé & Dojat, 2015). In our book, one of the authors of this study (Jean-Michel Hupé) shares his thoughts on the significance of these results for the understanding of synaesthesia and the development of the methodology of neuroscience.

Despite 20 years of extensive and intensive studies of synaesthesia of natural development (and, most likely, because of this fact), the direction of its further research is determined by several unresolved but intriguing questions. Many of them are discussed in detail by our interlocutors. One of the critical modern topics in the research of the phenomenon of congenital synaesthesia, at least in our opinion, are

the roles of environmental and genetic influences in the development of synaesthetic features of perception, both in terms of general mechanisms of consequence and in individual cases of manifestation of each of the synaesthesia varieties.

What does having synaesthesia entail?

The study of synaesthesia of natural development contributes to the clarification of some questions about the individual characteristics of the cognitive sphere and the substantial expansion of the field of their psychophysiological and psychogenetic studies. In particular, the explanation of the mechanisms of acquisition of synaesthesia in combination with the recognition of innate propensity to it may include the influence of full-colour printed materials and educational toys (alphabet bocks, magnetic letters) (Rich et al., 2005; Witthoft & Winawer, 2006), and the manifestation of innate sensory answers in response to semantically complex stimuli with excessive cognitive load for a given age (Jürgens & Nikolić, 2012). In this context, the question of the features of the relationship between cognitive processes and sensory aspects of psychological representation in the appearance and manifestation of congenital synaesthesia can be raised in particular. At the same time, innateness can be explained by some researchers as a tendency to form additional connections in the brain (neurogenesis) (Tilot et al., 2018), manifesting in a more developed way of thinking, greater flexibility of cross-modal transfers, and more effective memory (Smilek et al., 2001, 2002; Mills et al., 2006; Yaro & Ward, 2007; Barnett et al., 2008; Linn et al., 2008; Banissy et al., 2009; Brang et al., 2012; Watson et al., 2012; Alvarez & Robertson, 2013).

Some researchers recognize the status of congenital synaesthesia as a "variant of the norm", which is based upon individual features of development and functioning of neurocognitive mechanisms different from the statistically typical but equally adaptive, yet raise the question of the connection of certain aspects of this phenomenon to other neurophysiological aspects: e.g., autism, phantom limbs,

epilepsy, and other paroxysmal states, and schizophrenia (Ramachandran & Rogers-Ramachandran, 1996; Simner et al., 2009; Hughes et al., 2017).

In this regard, the study and refinement of the mechanisms of manifestations of high abilities in synaesthetes, including the detection of creative skills, more developed intelligence, memory, and language abilities, is a separate area of research (e.g., Mulvena & Walsh, 2005; Linn et al., 2008; Rothen & Meier, 2009). On the other hand, the interpretation of objectively detectable difficulties experienced by people with synaesthesia in the implementation of specific mental actions (for example, determining their place in the urban environment, remembering faces or performing mathematical calculations; see, for example, Day, 2016), which would include a comprehensive explanation of the reasons for this, often place scarcity and advantages equidistant. Emphasizing the need to neutralize deficits and rely on detectable cognitive benefits (creative, intellectual potential), researchers in some countries create projects — both local and national — to individualize training programs for children with synaesthesia and disseminate information about synaesthesia among educators.

Some studies demonstrate that the manifestation of individual features associated with synaesthesia is not limited to the domain of cognitive processes and mechanisms, but is integrated into the typology of personality, the dispositional and temperamental sphere (for example, Rader & Tellegen 1987; Rogowska, 2015; Rouw & Scholte, 2016; Sidoroff-Dorso, 2017). However, is congenital synaesthesia a consequence, a cause, or are there more specific but unknown intermediate factors? It is the direction of determinism of phenomena in the already discovered connections between synaesthesia and other individual features that remains a question still needing to be solved for researchers.

Thus, the situation around the studies of congenital synaesthesia contains a triple paradox, or a contradiction unfolding in several interconnected planes. This singularity lies in the fact that, according to attempts of continuous demographic research, 4.4% of all people have synaesthesia of natural development (Simner et al., 2006; Day,

2016), but this prevalence is not reflected in the amount of available information on this phenomenon, and the number of related studies. Secondly, a synaesthesia of natural development is a manifestation of human creativity, according to some researchers. At the same time, this phenomenon can be defined by other specialists as a phenomenon of perceptually excessive and even pathological nature. In turn, both assumptions contradict the scale of the detectable prevalence. Thirdly, being, a phenomenon of a special "end-to-end" cognitive process, including the work of sensory, perceptual and general cognitive mechanisms (and the results of some studies indicating the presence of synaesthetes features of intellectual and personal properties), synaesthesia can remain a neutral property that does not manifest itself and is not employed throughout life. This can also hamper the effectiveness of demographic research.

The variety of synaesthesia of natural development also finds different interpretations among scientists (one phenomenon or several?). The question of how different types of synaesthesia are connected and their statistically detectable division into five large groups or clusters (Novich et al., 2011), is directly related to psychogenetics. These clusters, however, often find expression in the form of multiple (manifestations of several types of stimuli similar in content in one person) and multispectrum (differing in content) synaesthesias, obviously demonstrating the extent of manifestation of this phenomenon in each individual possessing it (Sidoroff-Dorso, 2013). However, the methods of research need improvement in terms of developing technical capabilities to capture all known types, to clarify the criteria underlying the separation and classification of fixed types, and the development and implementation of methods for the refinement and verification of registered varieties. One of the issues that we outlined for our academic interlocutors was the question of the theoretical and practical rationale(s) for the separation of the phenomenon of synaesthesia on several possibly independent aspects.

When comparing the types, it is found that the mechanisms of the beginning of synaesthesia are rooted in some general control functions involved in the regulation of cognition, regardless of the

domain-specific experience (domain-general). According to the data on the systemic connections of stimuli and reactions, on identical laws of manifestation, and the adjacent manifestation of types, the phenomenon of congenital synaesthesia develops ontogenetically, probably, as a "thorough" cognitive process, covering a complex of mental functions, both "lower" and "higher". At the individual level, mechanisms of synaesthesia are highly specialized, formed through the development of specific subject areas, and weakly transferred to other areas of experience (domain-specific). Thus, the issue of typological unity (functional isomorphism) of congenital synaesthesia is, in our opinion, the private reflection of the general problems in cognitive science, developing as a question about degree of functional coverage with manifestation of a particular mental function (domain-general vs. domain-specific; see, for example, Schraw & Moshman, 1997).

A separate direction in the study of synaesthesia and related phenomena is implemented in a set of tasks to identify the links between congenital synaesthesia and cross-modal mechanisms of perception. Studies of the mediating function of attention (Mattingley et al., 2006; Mattingley, 2009; Laeng et al., 2014), as well as the role of the value of stimuli in the process of provoking synaesthesia (Dixon et al., 2006; Sidoroff-Dorso, 2010; Jürgens & Nikolić, 2012; Meier, 2013), demonstrate that synaesthesia manifests itself in such an interaction of sensory and cognitive processes, which is unlike the more holistic, flexible and direct representation of reality found in the intermodal community of the functioning of sensory systems. Moreover, it has been shown that congenital synaesthesia is an atypical link between sensory and cognitive mechanisms (Sidoroff-Dorso, 2017). Due to the unmotivated origin, impenetrability for reflection, and the additional and stable nature of the connections of synaesthetic stimuli and reactions, synaesthesia of natural development is not a complete functional analogue of cross-modal transfer (see, for example, Sagiv et al., 2011; Deroy & Spence, 2013).

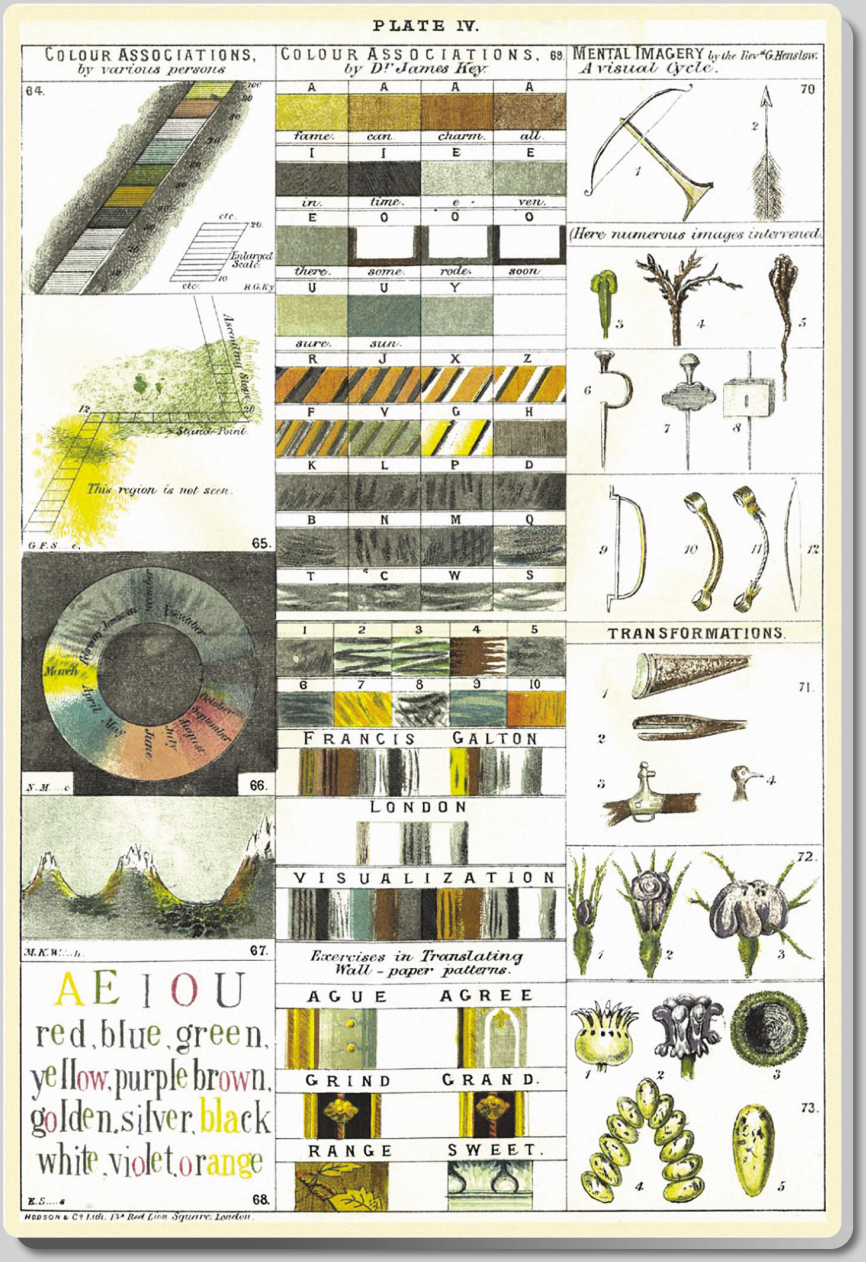
Nevertheless, some researchers point out that the maintenance of synaesthetic correspondences in a large number of individual cases tends to repeat cross-modal connections of universal order; for example, dark colour — low sound — low location in space (Marks, 1978;

Cytowic, 2002; Luria, 2006; Galeyev, 2004). Therefore, it is an ongoing discussion whether such patterns and synaesthetic experiences are based on a single mechanism, and if the strict division into sensory and cognitive processes (functional "modules") is valid methodologically. Among other things, ambiguous conclusions on the similarity or difference between synaesthesia of natural development and intermodal interactions of the cognitive plane affect the development of methods and means of identification of congenital synaesthesia in a particular person and, as a consequence, the accuracy of identifying the prevalence of this phenomenon. The question of the definition of synaesthesia is the first one we asked our interlocutors.

Regarding the history of synaesthesia research

A special historical chapter for our book was written by Jörg Jewanski, the world's leading expert on the history of synaesthesia research. The original description of the never-held round table, which brought together scientists from different countries and even times, shows the imaginary discussion concerning the term synaesthesia with historical accuracy. The reader is immersed in the logic underlying the origin and refinement of the concept of synaesthesia in the way it known now. The moment, place, personalities, and format chosen by Jewanski to "encourage" the discussion of synaesthesia are not accidental. Therefore, we would like to express our thanks that the many historical parallels that led to this choice continued to deliver equally significant results during our real meeting, the synaesthesia symposium in Moscow in 2019.

Synaesthesia of natural development was known before the dawn of psychology as a topic of scientific research. The first mention, which is almost unanimously recognized as a description of synaesthesia of natural development, belongs to Georg Tobias Ludwig Sachs, writing of his colour reactions to letters in his dissertation "The natural history of two albinos, the author and his sister" (Sachs was marked by an innate lack of melanin, albinism) (Jewanski, Day, & Ward, 2009). The first scientific and psychological reports were



The first coloured print of what a synesthete "sees". Reproduced from Francis Galton (1883). *Inquiries into human faculty and its development*, plate IV. London: Macmillan

compiled and published by Gustav Theodor Fechner (1871) and Francis Galton (1880). Work of Eugen Bleuler and Karl Lehmann (Bleuler & Lehmann, 1881) and Alfred Binet (Binet & Philippe, 1892) were devoted to the study of synaesthesia, as well as a series of publications by Raymond Wheeler (e.g., Wheeler & Cutsforth, 1925), and works and conferences of Georg Anschütz (see, for example, Anschütz, 1927). In the 1980s, after a decline caused by the neglect of subjective processes in behaviourism, the revival of research interest in the phenomenon of congenital synaesthesia was associated with the names of scientists such as Lawrence E. Marks (1978), Richard E. Cytowic (Cytowic, 1993), Peter G. Grossenbacher and Simon Baron-Cohen (Baron-Cohen & Harisson, 1996).

In Russia, the study of the phenomenon which is now called synaesthesia of natural development was approached from different scientific positions by several researchers. Historically, early reviews of synaesthesia were published by Nikolay O. Kovalevsky (1884), Vladimir N. Ivanovsky (1893), and Pavel P. Sokolov (1897). In the context of clinical physiology, a detailed description of synaesthesia was given by Ivan M. Sechenov (1884/1952), Vladimir M. Bekhterev (1896), and Ivan D. Yermakov (Sidoroff-Dorso, 2010). From the standpoint of understanding the neurophysiological foundations of the interaction of the senses, the question of synaesthesia was posed by Leonid A. Shifman (1948) and Sergey V. Kravkov (1948). Boris G. Ananiev included the idea of synaesthetic features of perception in the systematic study of the development of sensory knowledge (Ananiev, 1960). Some bright cases of synaesthesia were studied by Sergei L. Rubinstein (1989), and Nikolai A. Bernstein, who examined the synaesthete bell ringer Konstantin K. Saradzhev (Tsvetaeva, 1977).

The key Russian-language review of synaesthesia belongs to Revaz G. Natadze (1979). Natadze singled out involuntary synaesthesia (specific synaesthesia) as an effect of physiological adaptation, which differs from the expressively conditioned intermodal community of sensations (intersensory associations) and coordination of sense organs (change of sensation thresholds). Natadze defined specific synaesthesia as "the emergence of a 'sensation-like' experience of the sensory

The covers of the first Soviet (Russian) edition of 1969 (left) and its first two translated versions — the 1968 Basic Books (middle) and the 1969 Jonathan Cape (right)

quality of another modality without stimulation of the corresponding receptor." Modern researchers confirm this phenomenological nature of congenital synaesthesia. At the same time, the term specific synaesthesia does not separate a phenomenon from phenomena of a different origin. Thus, a synaesthesia of natural origin must be distinguished from phenomena with manifestations similar to some extent, such as post-traumatic synaesthesia, synaesthesia due to intoxication, or synaesthesia in an altered state of consciousness (ASC synaesthesia). Synaesthesia of natural development is one of the forms of specific synaesthesia, with a particular hierarchy, based on the systems of communication of stimuli and reactions (Sidoroff-Dorso, 2013b). What is the difference between congenital synaesthesia and synaesthesia from other forms of manifestation? Our interlocutors reflect on this, among other perspectives and questions.

In Russian psychology, the phenomenon of congenital synaesthesia is known from a long-term study conducted by Alexander R. Luria in the 1920s and 50s. Declaring the initial version of our book as the first in several book publications about congenital synaesthesia

in Russian, we nevertheless did it with serious reservations. First of all, it should be recognized that work with the diary entries of Sh[ereshevsky], conducted by one of us (Anton V. Sidoroff-Dorso), indicates that much about his synaesthesia did not get on the pages of *The mind of a mnemonist: A little book about a vast memory* (cf. Leontiev, 1931). Solomon Veniaminovich Shereshevsky admitted that, during the experiments conducted with his participation, he refrained from talking about synaesthetic reactions underlying his mnemonic images, "not wanting to complicate the explanation" (Shereshevsky, *Diary of a mnemonist*, 1957, unpublished). However, if scrupulous readers return to the text of the "Little book…" (the opinion that we learned for our book from each of our interlocutors-researchers) and make for themselves a reasonable conclusion, the assumption that synaesthesia is presented in it with a worthy completeness and undeniable originality, we implicitly concede the primacy of this wonderful edition.

Modern ideas about art and creative processes mostly feature a large number of voices that endow innate synaesthesia (obviously, due to equating general natural prerequisites to a particular predetermined advantage) with expectations of a high standard of artistic figurativeness—in painting, music, etc. (for example, Domino, 1989; Rothen & Meier, 2010; Ward et al., 2008). Vivid biographical precedents from the history of art, fragmentary statements of scientists, and examples from the program texts of famous masters can be cited as evidence. In our opinion, such a selective attitude to evidence not only detracts from the essence of creativity, tension, overcoming of self, and concentration that it may require, but also limits the understanding of the complex functional significance of synaesthesia at all levels of the structure of individuality and the correct representation of the individual features of cognition processes related to this phenomenon. Neuroscientists speak of the importance of comparative research, pointing to synaesthesia as a potential ("window into the mechanisms of the brain") for the study of creativity by its very nature of being part of human consciousness, as humans are a biological species.

Until recently, researchers in the field of arts, and even some psychologists, with rare exceptions, did not draw a clear boundary

between rich metaphor and the manifestation of innate synaesthesia in their understanding of the creative process and its results, putting on the same table the abundance of associative imagery and sensory sensibility in one author and the literal description of the reactions of innate synaesthesia in another. As was emphasized earlier, the phenomena of cross-modal interactions of different nature can be characterized as similar only in some aspects (e.g., systemic transfer, categoricity), but accepting them with uncritical unconditionality as identical would be a research mistake. Historically, this important division appears in art criticism in the 2010s in the works of Carol Steen, Greta Berman, Pat Duffy, and others (Steen & Berman, 2013; Duffy & Simner, 2010). Echoing Vladimir V. Nabokov's conviction that less "dense partitions surround the world of synaesthetes", we, nevertheless, would like to emphasize that overly exalted attitudes towards congenital synaesthesia should be balanced by the results of rigorous research (cf., Sidoroff-Dorso & Volokhova, 2016). To allow the reader to get acquainted with this issue in detail, Carol Steen, Lidell Simpson, Olga Balla, and Elena Rovenko kindly accepted invitations to become interlocutors.

The reader should be warned that our book practically does not touch on the complex area of cross-modal interaction in the implementation of cognitive and creative activities. This matter is included in the answers by our interlocutors barely "consciously"—only where they have the prerequisites to believe that the phenomenon of congenital synaesthesia forms a smooth transition with the universal cognitive mechanisms of intersensory interactions. However, the perspective of the collection includes an even more controversial aspect concerning art and creativity, namely, the question of the correlation of synaesthesia of natural development with individual differences, presumably manifested in the form of a penchant for creativity, high abilities for artistic depiction, and success in creative activity. With the examples from personal experience, given by some of our interlocutors with synaesthetic features of perception, the reader will be able to get weighty arguments about how, and how justifiably, we can consider synaesthesia as a manifestation of talent and giftedness.

Thus, unresolved questions regarding neurophysiological correlates of synaesthesia (structural and functional features of the brain of synaesthetes) and the role of environmental and genetic (and epigenetic) factors of development await researchers. The role and degree of sufficiency of attention in inducing synaesthetic reactions requires refinement, the nature of the revealed psychological and neurophysiological properties adjacent to synaesthesia needs to be systematically studied and, as a consequence, there is a need to develop ideas about the general factor underlying this phenomenon (genetic, psychophysiological "syndrome"). Also, the psychological status (in particular, cognitive and informative) of synaesthesia of natural development is not specified. The most contradictory interpretation of synaesthesia of natural development can be seen in the place that modern researchers assign to this phenomenon amongst other psychological phenomena. Among other things, this phenomenon can be defined as one of perceptually excessive or even pathological nature, but, on the other hand, it is often referred to by researchers as manifestations of creative activity, presumably associated with species-specific human abilities (Luria, 2006; Marks, 1978; Mulvenna & Walsh, 2005; Galeev, 2004; Cytowic, 2002; Ramachandran & Hubbard, 2001).

Each of the unresolved questions and problem areas listed above often finds an author's interpretation that determines the direction of the search for an answer to it (cf., Simner, 2012). The actual problems emerging around synaesthesia of natural development are saturated with acute dilemmas and substantial challenges, and hence research opportunities, potentials for factual enrichment of psychology and neuroscience (e.g., cognitive science, neurology, neuroesthetics) and their methodological improvement (see, for example, Cohen Kadosh & Henik, 2007). Our book is devoted to these research perspectives, defining their reflections and views which are held by the scientists, artists, and public figures invited by us as interlocutors.

Anton V. Sidoroff-Dorso
Sean A. Day

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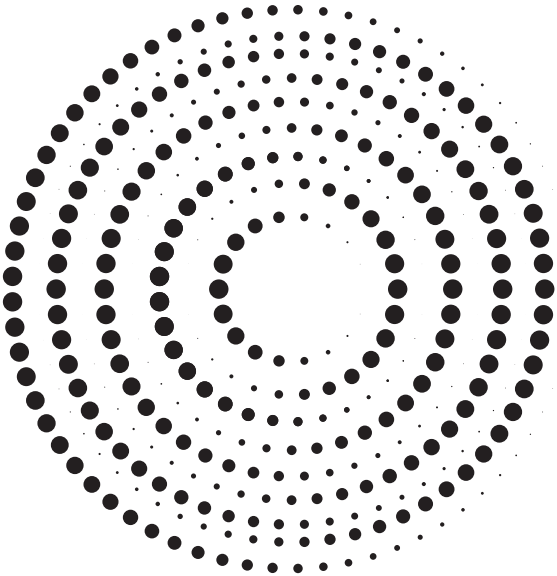
Interviews



Richard E. Cytowic:

> We'll need to search for more than one mechanism, too, given that synesthetic experience clusters into five distinct groups. Ours is a young science. There is plenty of material to mine for decades.

Richard E. Cytowic is best known for rekindling interest in synesthesia and returning it to mainstream science despite a hostile establishment that dismissed it as bogus. He grew up in a family of scientists and artists, intrigued by how things worked and how they appeared. He liked to take things apart and put them back together. As a 10-year-old gay kid in New Jersey, his father's medical profession told him he was sick; the State said he was a criminal; and the Church said he was damned. He hadn't done anything, yet he "wasn't supposed to" be. Told later by authorities that synesthesia wasn't supposed to be either, he welcomed the challenge of proving them wrong. In 1989, he wrote the first book in English devoted to the subject. Twenty years later, he and David M. Eagleman received the Montaigne Medal for *Wednesday Is Indigo Blue*, a book Oliver Sacks called "a unique and indispensable guide for anyone interested in how we perceive the world". A Clinical Professor of Neurology at George Washington University, Dr. Cytowic also holds a Master of Fine Arts and is an Artist Fellow of the District of Columbia. He has spoken at the Library of Congress, the Smithsonian, museums, concert venues, and cultural institutions worldwide. In 1963, when the Twist was the latest dance craze, ten-year-old Richard got on stage in front of 2,000 people at the Latin Casino and danced with Liberace. It was his chance to wow them.

How do you define synaesthesia? Is it one phenomenon or several ones?

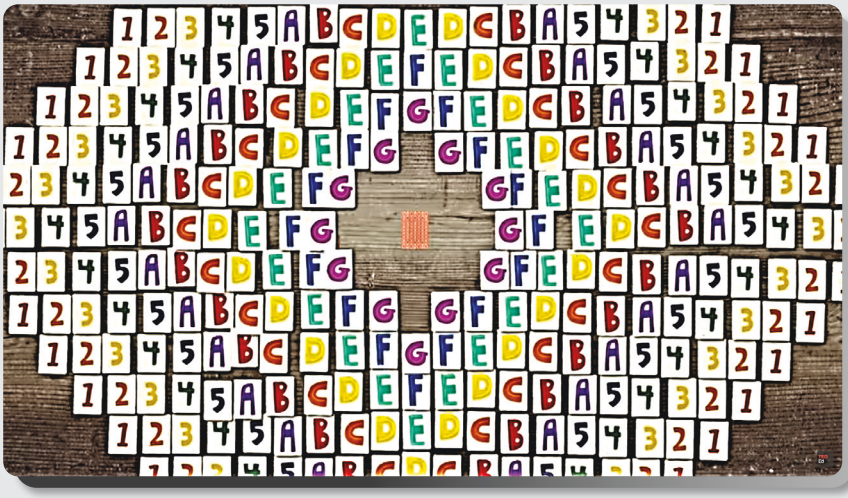
This is a difficult question. "Coupled senses" is inadequate because graphemes, for one, do not constitute a sense. Then you have acquired synesthesias due to head trauma, drug ingestion, or meditative states, which are different from congenital synesthesia. Analyzing synesthesia types among nearly 20,000 individuals shows that they cluster into five types. Complicating this categorization, however, is spatial sequence synesthesia that doesn't co-occur with any other type. We can conclude, then, that "synesthesia" is an umbrella term for a number of mechanisms that result in a similar phenotype.

To what extent is synaesthesia inborn (genetically determined)? What are the causal influences of learning and cognition in its occurrence?

Overt synesthesia requires two things: a genetic predisposition to more strongly cross-connect different brain areas, and exposure at a young age to cultural artifacts such as alphabets, numerals, the names of foods a child eats, clocks, musical notes and scales, and more. The timeline for when youngsters develop certain cognitive skills is well known and David M. Eagleman and I laid out such a timeline in *Wednesday is Indigo Blue*. What no one has yet done is see whether different types of synesthesia manifest themselves at a particular age or not. This would be quite useful to know, as well as possibly shedding light on how the qualia of these cultural artifacts couples with a quotidian perception. We know next to nothing about the mechanism of how this happens, so this remains a puzzle for young researchers to tackle.

In what ways is synaesthesia an advantageous, an impeding and a neutral condition?

Almost all synesthetes say that it helps them remember telephone numbers, lists, names, calendar appointments and so on. One professor of neuropathology uses it to help him remember tumor classifications, and says, "You should see the beautiful array of colors in the brain."



"Almost taken for granted is the sense of joy and pleasure that the phenomenon gives those who possess the trait." Printed with permission from TED-Ed. *What color is Tuesday? Exploring synesthesia* | Richard E. Cytowic | For more TED-Ed, visit ed.ted.com

"What no one has yet done is see whether different types of synesthesia manifest themselves at a particular age or not. This would be quite useful to know, as well as possibly shedding light on how the qualia of these cultural artifacts couples with a quotidian perception." Printed with permission from TED-Ed. *What color is Tuesday? Exploring synesthesia* | Richard E. Cytowic | For more TED-Ed, visit ed.ted.com


The Man Who Tasted Shapes

Richard E. Cytowic is giving a talk as Key Speaker of the scientific programme of the IASAS Moscow Synaesthesia Symposium. First day of the Symposium held in the venue of the Moscow State University of Psychology and Education. October 17, 2019. Photos: MSUPE Press Office

Almost taken for granted is the sense of joy and pleasure that the phenomenon gives those who possess the trait. For many the "wow" factor remains intense over their lifetime; for others it fades. But the experience seems to provide a creative spark for many, guiding them in their choices in writing poetry, composing music, painting, or even arranging their furniture.

Synesthesia seems to be an impediment when it is bidirectional as it is in Julie Roxburgh, a music teacher who has been studied extensively and who lives a relatively quiet, secluded life to avoid overstimulation.

Is it ever neutral? In the sense that synesthetes take their texture of reality for granted and don't make a big deal of it. A useful comparison would be with vision in nonsynesthetes. If you stopped and pondered how vision works it's absolutely flabbergasting. And yet, because we see all the time and because vision is our texture of reality, it seems quite normal and nothing to make a fuss over.

Are people with synaesthesia special in any other way? Do all people have synaesthesia to some extent?

Well, they seem to have elevated memories and tend to be creative in diverse ways. Do all people have synesthesia to some extent? Yes, as evident by the cross-modal couplings they make when using metaphor as well as in everyday perception such as the lipreading we all do and increasingly rely on as the background volume gets louder. The interesting question, of course, is where the dividing line is between ordinary perception informed by cross modal mechanisms and the outward phenotypic phenomenon that we call synesthesia.

What is your story (and impression) of reading Alexander Luria's *The Mind of a Mnemonist*?

I discovered the book while browsing the subbasement library stacks. During my residency, I often used 10-minute blocks of time spent deep down there to escape the signal of the hospital's page operator. I had studied mnemonic techniques as a teenager with "the" Harry Lorayne and became sufficiently adept to appear on television with him demonstrating prodigious feats of memory. Naturally, I was

intrigued by Luria's title. Its small size fit conveniently into my white coat pocket. I checked it out, and the rest is history. Luria's book is where I learned the word synesthesia. Being a lover of words and their origins, I immediately noted its similar root with anesthesia, and then filed the word in the back of my mind until I chanced upon Michael Watson, the literal Man Who Tasted Shapes.

Why is it important to do research into synaesthesia? What are its promises for cognitive science or science at large?

How could one not? Synesthesia is inherently fascinating. For some, it might even seem taboo, given how it violates standard notions of how perception is supposed to work. Synesthesia is the ideal candidate for perceptual genomics, the study of how specific genes influence the way people experience the world.

People don't usually think of perceptual or sensory traits as hereditary, but they are. Musical ability is one such example of a talent that runs in families. The Bach pedigree is a prime example, though hardly unique. Perfect pitch is another, and one that shares features with synesthesia: It is all or nothing (you either have it or you don't), it manifests at an early age without the need for practice, and it is a lifelong trait.

It is important to do research because synesthesia is no mere curiosity. Rather, it is a window onto a vast expanse of both mind and brain. It is an example of how nature reveals her secrets through exceptions or anomalies. This is to say that studying it can illuminate the mechanisms of ordinary perception and how all brains work.

Which type of synaesthesia fascinates and/or intrigues you the most? What is the most memorable (interesting, baffling) case of synaesthesia that you came across during your career as a synaesthesia researcher? Why was it interesting and how would this contribute to (neuro)science if we could know its mechanisms?

Asking me to narrow it down isn't fair. The odd ones like audiomotor, emotionally-mediated, and orgasmic synesthesias are puzzling, and grapheme personification is a real head scratcher. We'll need to make

progress in understanding more common types first. The real prize will be understanding how a genetic propensity to connect brain areas more robustly than usual becomes entrained by cultural artifacts learned in early life such as alphabets and numerals. We'll need to search for more than one mechanism, too, given that synesthetic experience clusters into five distinct groups. Ours is a young science. There is plenty of material to mine for decades.

What is your current "pet peeve" most annoying misconception about synaesthesia? What ideas about synaesthesia has your experience of researching synaesthesia made you get rid of? What do you feel is the main thing currently being overlooked or ignored in synaesthesia research?

I don't really have one aside from a general dismay at the lack of critical thinking among the general population. Over the years, I've tempered my emphasis on emotional coloring — what Sean calls the "wow factor" — and changed my understanding of spatial location — the projector-associator distinction. The former occurs on a spectrum, and the latter may well be influenced by how one asks the question of where do you see your synesthesia?

In your UCLA talk at the 1st IASAS Synaesthesia Symposium, you mentioned Jakob Johann von Uexküll's concept of *Umwelten*. To what extent and in what qualitative ways do you think synaesthetes' *Umwelten* are different from those of non-synaesthetes?

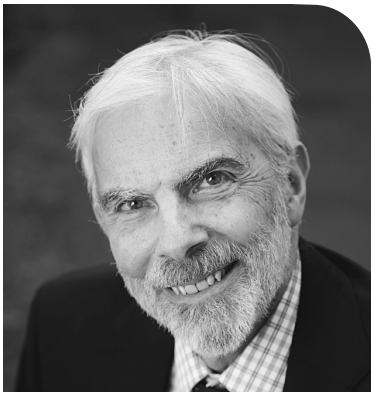
I say that synesthetes have a "different texture of reality" than the remaining 96% of us. For example, a blind person might say, "Everywhere you look, you're always seeing something. Doesn't it overwhelm you, having to see things all the time?" No, we say, because seeing belongs to our texture of reality. The analogy implies that synesthetes have a subjectively different umwelt that we cannot comprehend firsthand. The superimposed qualia are so alien to us, and this is what makes the phenomenology of synesthesia fascinating.

Being a non-synaesthete yourself, would you want to have synaesthesia? If so, which type of synesthesia would you most like to have, towards doing research on yourself?

Of course, I would love to have the trait! How could one not feel wistful at missing out when synesthetes talk about such lambent, fulsome sensations? I love music—jazz, orchestral, opera, vocal, chamber—and it evokes strong, pleasurable emotions in me. I think I'd like to have colored hearing so that I could see what I hear and feel. We know so much at the anatomical and physiological level about how sound and sight interact. It would be wonderful to finally understand how the subjective synesthetic experience arises from this interaction. I think it will be some time, if ever, before we know.

Lawrence E. Marks:

> Better understanding synesthesia may also help us to understand, better than we do now, how phenomenal experiences are related to underlying neural and neurochemical mechanisms — and may thereby help shed light on the still-obscure mind-body relation.



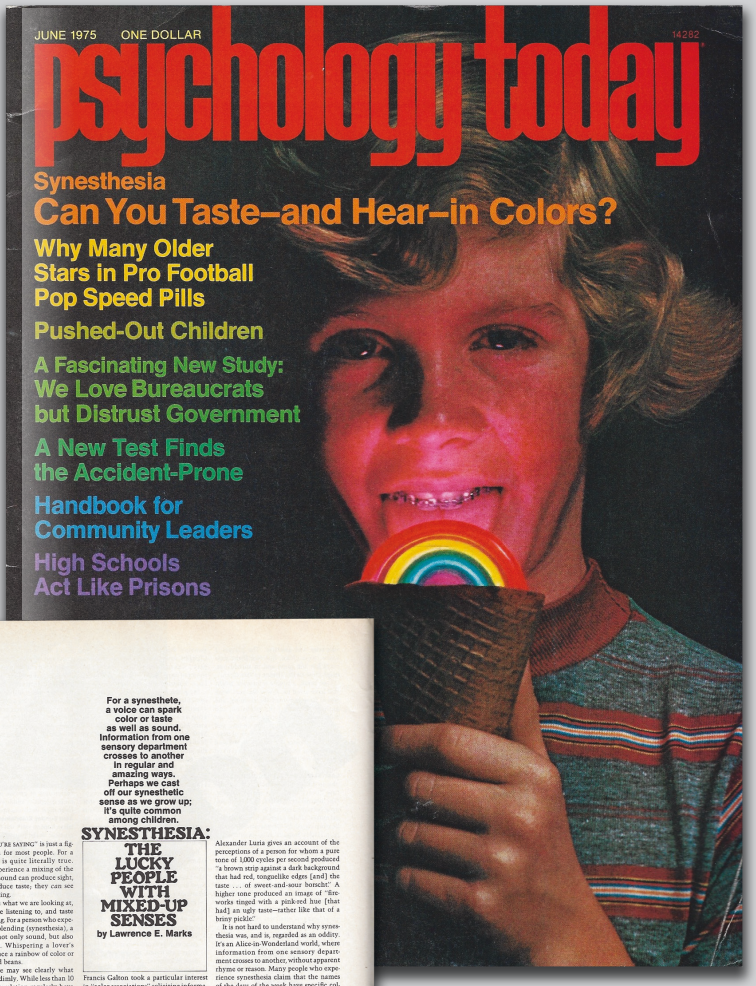
Lawrence E. Marks is an Emeritus Professor of Epidemiology and Psychology at Yale University. He received a Ph. D. in Psychology from Harvard University. After a post-doctoral year at Harvard, Marks came to the Pierce Laboratory in 1966. He was promoted to Fellow in 1984 and served as Director from 1999–2009. Originally trained as a cognitive psychologist specializing in language, Marks has devoted most of his scientific career to elucidating human sensory and perceptual processes, including mechanisms of multisensory integration and interactions of sensory with cognitive processes in the coding and representation of perceptual information. Among his awards and honours are election as Fellow of the Society for Experimental Psychologists, the American Association for the Advancement of Science, the New York Academy of Sciences, the American Psychological Association, and the Association for Psychological Science; election to the Connecticut Association for Science and Engineering; a Jacob Javits/ Claude Pepper Award from the National Institutes of Health; and an honorary doctorate from Stockholm University. Lawrence E. Marks has supported and participated as key speaker in conferences on synaesthesia and is currently a board member of the American Synesthesia Association. He is the author of well over 200 prominent articles in the field if psychology, has co-authored multiple scientific articles on synaesthesia along with the classic book *The Unity of the Senses: Interrelations among the Modalities* (1978).

How do you define synaesthesia?
Is it one phenomenon or several ones?

Synesthesia is increasingly being defined as a "neurological condition," in which perceptual or conceptual stimuli arouse atypical perceptual or cognitive responses, in addition to responses typically considered appropriate to the stimuli (e.g., Asher et al., 2009; Simner et al., 2009; Brang, Rouw, Ramachandran, & Coulson, 2011). By implication, older definitions of synesthesia typically focused on its phenomenology — for example, perceiving color in music (music-color synesthesia) or in achromatically printed letters or numbers (grapheme-color synesthesia) — and those definitions are perhaps seen by some researchers these days as not only outdated but old-fashioned, akin to the way that biomedical researchers now define diseases in terms of their underlying biological mechanisms instead of clusters of symptoms.

Old-fashioned my definition of synesthesia may be — and old-fashioned I may be! — but I also believe that there is justification, besides mere orneriness, for my predilection to continue (at least for now) defining synesthesia in terms of the phenomenal experiences per se. In particular, I dislike applying both "neurological" and "condition" to synesthesia's definition. In reverse order, I dislike "condition" because its use here strikes me as a weak substitute for "disorder" and I do not think of synesthesia as a disorder. A better and more neutral noun would be "trait". And I dislike "neurological" for the same reason, because the discipline of neurology deals with disorders of the nervous system. A better and more neutral alternative here would be "neurophysiological". If, of course, as I believe, all mental events and behavioral acts have a neurophysiological basis, then there's no special reason to even bothering calling synesthesia "neurophysiological," for everything in a person's mind presumably has some kind of physical-neurophysiological-neurochemical underpinning.

But I do believe there's a real and important theoretical divide here: between those who would like to identify the neurophysiological bases of synesthetic experiences and then define synesthesia in terms



For a synesthete, a voice can spark color or taste as well as sound. Information from one sensory department crosses to another in regular and amazing ways. Perhaps we cast off our synesthetic sense as we grow up; it's quite common among children.

SYNESTHESIA: THE LUCKY PEOPLE WITH MIXED-UP SENSES

by Lawrence E. Marks

"I SEE WHAT YOU'RE SAYING" is just a figure of speech for most people. For a few, the phrase is quite literally true. These people experience a mixing of the senses in which sound can produce sight, or sight can produce taste, they can see what you are saying.

We usually see what we are looking at, hear what we are listening to, and taste what we are eating. For a person who experiences sensory blending (synesthesia), a voice produces not only sound, but also colors or tastes. Whispering a lover's name may produce a rainbow of color or the taste of baked beans.

The synesthete may see clearly what the rest of us see dimly. While less than 10 percent of the population regularly have such experiences, my research shows that most people have at least some capability of sensing the world synesthetically.

Synesthesia is a fantastic and fascinating experience that has attracted the attention of poets and writers, as well as scientists. The French writer Théophile Gautier reported: *My hearing was fantastically developed. I heard the clamor of colors. Green, red, blue, yellow sounds all came to me as perfectly distinct waves.*" To the 19th-century poet Arthur Rimbaud, the vowel sounds were endowed with colors. In "Sonnet of Vowels," he describes A as being black, E as white, I as red, O as blue, and U as green.

There are many types of synesthesia, since any or all of the five senses may be simultaneously involved. The most common varieties are visual images aroused by sounds, or "colored hearing," and visual images produced by taste.

The British philosopher-scientist Sir Francis Galton took a particular interest in "color associations," soliciting information from around the world. "To ordinary individuals" he wrote, "one of these accounts seems just as wild and lunatic as another." One of his correspondents wrote: *"Each word is a distinct whole. I have always associated the same colors with the same letters, and no effort will change the color of one letter, transferring it to another . . . Occasionally, when uncertain how a word should be spelt, I have considered what color it ought to be, and have decided in that way. I believe this has often been a great help to me in spelling, both in English and foreign languages."*

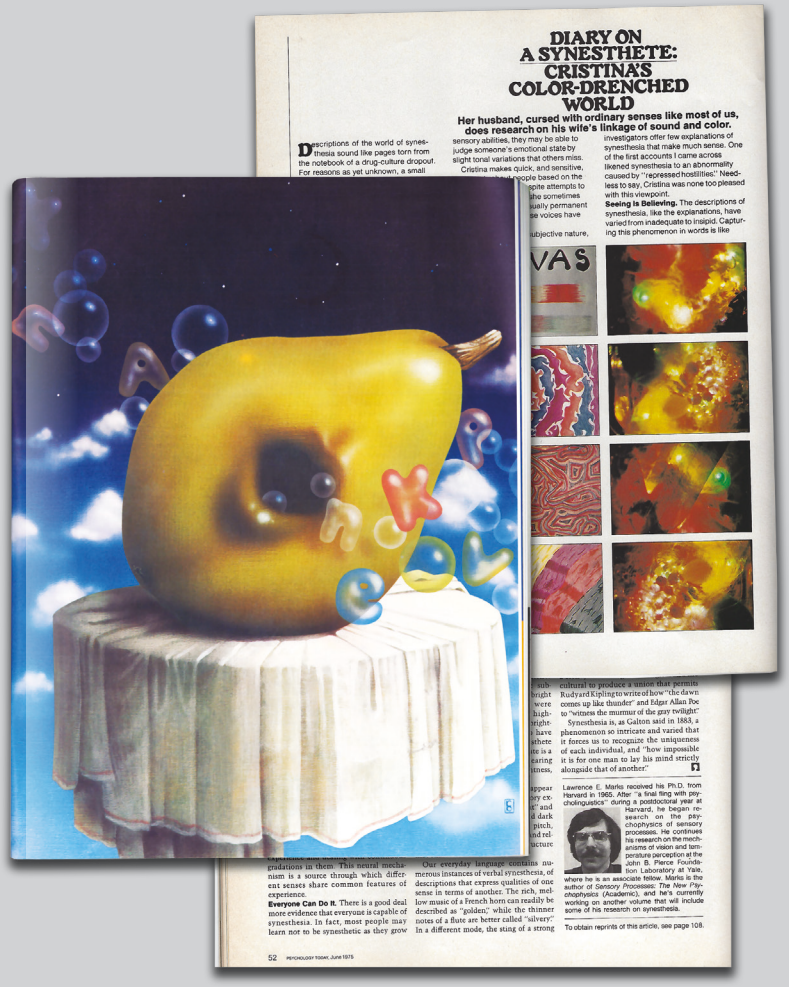
Others claim that tastes arouse colors, or that words produce tastes. One young woman, for example, reported that the spoken sound of "Francis" had the flavor of baked beans, "French" had the savor of charlotte russe, and "Italy" had the taste of small, white pickled onions.

In his book *The Mind of a Mnemonist*, Alexander Luria gives an account of the perceptions of a person for whom a pure tone of 1,000 cycles per second produced "a brown strip against a dark background that had red, tonguelike edges [and] the taste . . . of sweet-and-sour borscht." A higher tone produced an image of "fireworks tinged with a pink-red hue [that had] an ugly taste—rather like that of a briny pickle."

It is not hard to understand why synesthesia was, and is, regarded as an oddity. It's an Alice-in-Wonderland world, where information from one sensory department crosses to another, without apparent rhyme or reason. Many people who experience synesthesia claim that the names of the days of the week have specific colors, but they disagree on what those colors are. One person wrote Galton that "When I think of Wednesday I see a kind of oval flat wash of yellow–emerald–green; for Tuesday, a gray-sky color, for Thursday, a brown-red irregular polygon, and a dull yellow smudge for Friday." To others, Tuesday is clearly red, while Thursday may be a square or a circle.

Despite these idiosyncrasies, there exists a core of similarities in synesthetic experiences. This common core is most readily revealed in reports of visual colors that are associated with speech sounds. Within the realm of colored hearing, not all speech is equally effective in producing visual images. For the most part, it is vowel sounds that are most potent in evoking images. Consonants are clearly less powerful.

Red As in "Mama." In the reports on colors produced by vowel sounds, obtained from over 400 people, I find more than



DIARY ON A SYNESTHETE: CRISTINA'S COLOR-DRENCHED WORLD

Her husband, cursed with ordinary senses like most of us, does research on his wife's linkage of sound and color.

Descriptions of the world of synesthesia sound like pages torn from the notebook of a drug-culture dropout. For reasons as yet unknown, a small

sensory abilities, they may be able to judge someone's emotional state by slight tonal variations that others miss.

Cristina makes quick, and sensitive,

despite attempts to the sometimes ually permanent se voices have

subjective nature,

investigators offer few explanations of synesthesia that make much sense. One of the first accounts I came across likened synesthesia to an abnormality caused by "repressed hostilities." Needless to say, Cristina was none too pleased with this viewpoint.

Seeing Is Believing. The descriptions of synesthesia, like the explanations, have varied from inadequate to insipid. Capturing this phenomenon in words is like

VAS

cultural to produce a union that permits Rudyard Kipling to write of how "the dawn comes up like thunder" and Edgar Allan Poe to "witness the murmur of the gray twilight."

Synesthesia is, as Galton said in 1883, a phenomenon so intricate and varied that it forces us to recognize the uniqueness of each individual, and "how impossible it is for one man to lay his mind strictly alongside that of another."

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To obtain reprints of this article, see page 108.

gradations in them. This neural mechanism is a source through which different senses share common features of experience.

Everyone Can Do It. There is a good deal more evidence that everyone is capable of synesthesia. In fact, most people may learn not to be synesthetic as they grow

Our everyday language contains numerous instances of verbal synesthesia, of descriptions that express qualities of one sense in terms of another. The rich, mellow music of a French horn can readily be described as "golden," while the thinner notes of a flute are better called "silvery." In a different mode, the sting of a strong

The cover of *Psychology Today* magazine of June 1975. The issue contained one of the pioneering articles in popular science press that entailed a resurgence of scientific and general public's interest in developmental synaesthesia. Entitled *Synesthesia: The Lucky People with Mixed-Up Senses*, Lawrence E. Marks' publication helped establish an overall positive attitude to the phenomenon and rekindled scientists' enthusiasm for its vigorous research. Provided by Lawrence E. Marks and Patricia Lynne Duffy

of underlying neural events, and those who prefer (as I do) to continue to define synesthesia in terms of the experiences themselves and the conditions under which those experiences arise.

As should be clear, I fret a good deal as to how to define synesthesia. In the past, like some others, I've often finessed the question of synesthesia's definition by indicating, albeit vaguely, that the definition will become clear once scientists know much more about it; often, definitions evolve as science progresses and scientific understanding increases. Consider how definitions in physical science have evolved over time, an example being the changing definition of atoms. Atoms are no longer the relatively simple, indivisible particles of Democritus, nor even systems comprising nuclei, formed of indivisible neutrons and protons, surrounded by their orbiting electrons. Perhaps future definitions of psychological terms too will evolve as scientific understanding grows. But I no longer find this certain, in part—but only in part—because I see scant progress in this direction.

The core of the problem is that so many psychological traits do not seem in any obvious way to be "things", at least not in the ways that we think of physical objects as "things". Psychological traits are often relational, often contextual– and therefore are often appropriately treated as constructs of discourse within the scientific community (for an early statement of psychological constructionism, see Gergen, 1985). Some may of course argue that the same of is true of atoms—but, in my view, psychological traits such as intelligence, creativity, and synesthesia are not the same kinds of entities or "things" as electrons, photons and kinetic energy. There is something compelling to Galilei Galileo's remark that he did "not believe that for exciting in us tastes, odors, and sounds there are required in external bodies anything but sizes, shapes, numbers, and slow or rapid movements; and I think that if ears, tongues, and noses were taken away, shapes, numbers, and motions would remain, but not odors or tastes or sounds" (Galileo 1623, ed. 1960, p. 311). The future may, of course, prove me wrong about this. But for now, I'll stick to a core belief: that even though physical processes underlie all mental events and behavioral acts, such a belief in ontological

reductionism does not compel a corresponding belief in epistemological reductionism. And, consequently, at least for now, I still place phenomenology at the heart of my definition of synesthesia.

Intimately tied to the matter of synesthesia's definition is the question whether synesthesia is unitary. Is "mirror-touch," for example, a form of synesthesia? Perhaps a non-canonical form but a form nonetheless? And, if so, in what way? The contrast between mirror-touch and, say, grapheme-color synesthesia reminds me of the distinction, in the domain of memory, between semantic memory and episodic memory—between, on the one hand, memories of what words and concepts mean and, on the other hand, memories based in explicit events. Remembering that aqua is a color that falls between blue and green differs, in kind, from remembering that my brother's hair has recently become mostly white—and these two kinds of memory differ in way that resembles the way that grapheme-color and other canonical forms of synesthesia differ from mirror-touch. When a grapheme-color synesthete perceives the letter "A" as red, for example, the redness is, in a sense, part of the meaning of "letter A-ness". But the semantic nature of many such examples of canonical synesthesia differs from the episodic nature of mirror-touch, as when someone feels a tactile sensation on her arm when she sees someone else touched on the arm. Perhaps mirror-touch is, then, a form of synesthesia but an atypical form (see Rothen and Meier, 2013, however, who question even characterizing mirror-touch as synesthesia).

One problem, to be sure, is determining the locations of the borders separating various forms of synesthesia from one another, as well as determining the borders separating what is synesthesia from what is not. If synesthesia includes mirror-touch, then should it also include empathic pain? And if synesthesia includes empathic pain, then what of the couvade syndrome—in which partners of pregnant women report having the symptoms that the women report during their pregnancy? For further discussion, see Marks & Mulvenna (2013a).

Does being semantic rather than episodic help define synesthesia, or help define canonical forms of synesthesia? Do characteristics such as long-term consistency matter? Should they? In this regard, there

are reports in the literature of transitory synesthesia-like experiences (e.g., Riggs and Karwoski, 1934), and Kirschner and Nikolić (2017) have recently written about transitory events that they call examples of "one-shot synesthesia". Is one-shot synesthesia canonical?

Perhaps synesthesia is best considered not as a single kind of phenomenon but instead as a multiplicity, as a manifold. This is a matter that I've considered elsewhere (Marks, 2011; Marks & Mulvenna, 2013a). There is considerable resistance to this notion, especially given the tendency for scientific explanations and theories to rely on combinations of defining causal processes or agencies. This tendency may rest not on personal predilection or historical accident, but instead may reflect the difficulty that most of us have in learning or identifying concepts that are disjunctive rather than conjunctive—as reported by Bruner, Goodnow & Austin (1956). Bruner et al. showed that people find it relatively easy to learn conjunctive rules, for instance, that "all Xs are large red circles", but much harder to learn disjunctive rules, for instance, that "all Xs are either red circles or green squares". Conjunction is easy, disjunction hard. And maybe the trait synesthesia, is, or should be, characterized by disjunction rather than conjunction.

To what extent is synaesthesia inborn (genetically determined)? What are the causal influences of learning and cognition in its occurrence?

Questions of this sort are often asked about behavioral/cognitive processes, especially of intelligence. I think that the questions themselves are problematic, for at least two reasons: First, these questions implicitly assume that there's a "thing" to assess—something that's unitary, in some way—and, second and perhaps even more importantly, that it's possible to quantify the "extent" to which "things" such as synesthesia are inborn or learned. Learning and experience doubtless matter, but we don't really know just how. Language is doubtless important… sometimes… but probably not always. I've suspected, for example, that at least some synesthetic responses to pains are rarely if ever mediated by language. On the other hand, one cannot experience grapheme-color synesthesia without first learning graphemes,

and the acquisition of grapheme-color synesthesia apparently takes place slowly, over a period of years (Simner et al., 2009).

In this regard, let's assume, first, that there is some genetic basis to synesthesia, second, that this is true for grapheme-color (or any grapheme-induced or written-word-induced synesthesia) and, third, that some people are raised in cultures that lack written language. Given these three assumptions, then… well… what then can we say about those potential synesthetes who live in cultures that lack written language? Obviously, with no graphemes (or ideograms), then no grapheme-color synesthesia. Will, therefor, a person who is born with a genetic propensity for synesthesia and who might develop grapheme-color synesthesia in a literate culture instead, in a non-literate culture, develop some other form or forms of synesthesia? Or might that person develop some other trait instead of synesthesia? If the genetic alleles that underlie synesthesia are distributed uniformly and equivalently in different human populations, but some cultures lack graphemes, then will those cultures also produce relatively fewer synesthetic individuals (compared to cultures with graphemes), simply because grapheme-evoked synesthesia is absent? Or will the synesthesia genes in those cultures "compensate" for the absence of grapheme-evoked forms of synesthesia by expressing themselves in relatively more instances of other forms of synesthesia? Even if this question remains forever in the realm of the Gedanken, thinking about how one would answer the question may be helpful in crystallizing a full, coherent theory of synesthesia.

In what ways is synaesthesia an advantageous, an impeding and a neutral condition?

A few synesthetes have told me that their synesthesia has helped them, for instance, as children while learning arithmetic in school. Others, less frequently, have said that their synesthetic responses sometimes create confusion. A priori, it seems likely that there are diverse ways that synesthesia may confer benefits and, perhaps, costs to everyday activities, and there is already a growing literature on synesthesia's potential benefits, as well as costs. I shall not respond further to this

question, except to note that there is as much to learn by studying individuals in depth about the range and characteristics of their experiences. Synesthesia is a topic that lends itself especially well to those idiographic approaches so often derided by proponents of the nomothetic. See also my response to the next question.

Are people with synaesthesia special in any other way? Do all people have synaesthesia to some extent?

Several studies have explored the possibility that synesthesia is associated with benefits to memory, although there can also sometimes be costs from interference (for a review, see Meier and Rothen, 2013). But I shall focus here instead on another possible benefit — that synesthetes are likely to be more creative (on average) than people lacking synesthesia. Empirical findings (e.g., Domino, 1989; Mulvenna, 2012; see Marks and Mulvenna, 2013b; Mulvenna, 2013) support informal observations that synesthesia is more prevalent than would otherwise be expected amongst artists, musicians, writers, and other individuals who are commonly deemed to be especially creative. The question is often asked in this way: Are people with synesthesia more likely that those lacking synesthesia to be creative (or are synesthetes in specific ways more creative than non-synesthetes)? We may also ask the question the other way around: Are highly creative people more likely than less creative ones to also be synesthetic?

In trying to answer to these questions, we quickly face the complexity of creativity too, a psychological-behavior trait that, like synesthesia, is itself multidimensional, and perhaps also not unitary. There is evidence, for example, that synesthesia may be especially closely associated with a particular type of creativity, namely, creative cognition — the propensity to generate ideas that are both novel and appropriate to the task at hand (Mulvenna, 2012).

The second part of the question — does everyone have at least some degree of synesthesia? — points to an issue that is also pertinent to question 1: how to define synesthesia. For example, are those behaviors that are sometimes called "synesthetic tendencies", what Gail Martino and I called examples of "weak synesthesia" (Martino

and Marks, 1990), really kinds of synesthesia? Maybe, but maybe not (see, e.g., Deroy and Spence, 2012). To be sure, there are many ways that synesthetic behaviors arise in individuals who may not fit the typical definitions of being synesthetic. Thus, many of us who do not experience musical notes as having colors will readily appreciate that some notes are darker or brighter than others. A person may report, for instance, that a chord of D-major playing on a piano (but not other major chords such as E-major or A-major) resembles yellow more than blue, without claiming that the D-major chord actually produces a yellow color. In this regard, a few researchers have suggested that synesthesia may be appropriately represented as a continuum (e.g., Glicksohn, Salinger and Roychman, 1992; Hunt, 2005).

What is your story (and impression) of reading Alexander Luria's *The Mind of a Mnemonist*?

I have no special story here. I was familiar with some of Luria's neuropsychological work well before learning of his study of the synesthetic Shereshevsky (Luria 1968). Because it's hard now to recall my exact response years ago to reading *The Mind of a Mnemonist*, I shan't say anything more about this.

Why is it important to do research into synaesthesia? What are its promises for cognitive science or science at large?

I appreciate the opportunity that question 6 provides to quote the second century BCE Roman-slave-turned-playwright Publius Terentius (Terence): "Homo sum: humani nil a me alienum puto" (Heauton timorumenos 77; see Ricord, 1885) — in a contemporary translation, "I am a person, and nothing human can be foreign to me." My answers to the first five questions already suggest several possible answers to this sixth question. Here, I'll briefly mention four.

First, better understanding synesthesia may also help us to understand, better than we do now, how phenomenal experiences are related to underlying neural and neurochemical mechanisms — and may thereby help shed light on the still-obscure mind-body relation.

Second, better understanding synesthesia may spur us to rethink the usefulness of the notion of "human nature". Foregoing metaphysical

or theological principles, it is just as important to be able to acknowledge, identify and understand the sources and characteristics that make each person unique as it is to be able to identify those mechanisms that are invariant or universal across humans. Whatever human nature may be, it's description must ipso facto acknowledge and identify what statisticians call variances as well as central tendencies in mental and behavioral processes. Averages are mere abstractions.

Third, better understanding synesthesia should help us to understand, far better than we do now, the relations among synesthesia ("strong synesthesia"), synesthesia-like processes in individuals who do not report phenomenal experiences of synesthesia ("weak synesthesia") and the evocation of weak or, conceivably, strong synesthesia in multimedia art — most notably, in digital multimedia art — sometimes dubbed "digital synesthesia" (see Marks & Mulvenna, 2016; and, more generally, the articles in Gsöllpointner, Schnell & Schuler, 2016).

And fourth, better understanding how synesthesia relates to creativity may help us to understand how the presence of a relatively closed cognitive system can facilitate the operation of a more open one. When it arises in childhood, synesthesia typically develops relatively gradually, and thereby starts as a relatively open system, as, for example, different graphemes come to reliably take on different colors. With time, however, the synesthetic connections become stable and reliable, so the synesthesia thereby becomes, in adulthood, a relatively closed system. (In characterizing the development of synesthesia in this way, I'm ignoring, of course, cases of transitory synesthesia, which imply a more open system.) By way of contrast, creativity, especially creative cognition, provides an example par excellence of an open cognitive system. Perhaps a handbook of synesthesia of the 21st century will explicate how the presence of a relatively closed system, synesthesia, can foster the operation of a relatively more open system, creativity.

Which type of synesthesia fascinates and/or intrigues you the most? What is the most memorable (interesting, baffling) case of synesthesia that you came across during your career

as a synesthesia researcher? Why was it interesting and how would this contribute to (neuro)science if we could know its mechanisms?

Oh, dear! This is like asking me which of my children or grandchildren fascinates or intrigues me the most! As with my children and grandchildren, every type of synesthesia is fascinating and intriguing — and wonderful! — is its own unique and intrinsic ways. Even synesthetes of the same 'type' are individuals, unique, all having their own idiosyncrasies as well as any communalities. Grapheme-color synesthetes, for example, are known to argue rather vigorously over the colors taken on by the letters of the alphabet. Although there's no way to prove that all synesthetes differ from one another, even when they share one of its forms (e.g., grapheme-color), but I suspect that this is indeed so.

This said, some differences amongst synesthetes do especially intrigue me — for special reasons. In the interview, I mention the analogy I see in the difference between mirror-touch versus other forms of synesthesia (such as grapheme-color) and the distinction between episodic and semantic memory. If the analogy is well-founded, then I suspect that it may bear important implications for corresponding, underlying neural mechanisms: Research in memory has provided ample evidence, for example, that episodic memory (remembering events) and semantic memory (remembering meanings) rely on anatomically and physiologically distinct processes (see, e.g., Tulving, 2002); perhaps correspondingly different processes also underlie mirror-touch versus other forms of synesthesia.

What is your current "pet peeve" most annoying misconception about synesthesia? What ideas about synesthesia has your experience of researching synesthesia made you get rid of? What do you feel is the main thing currently being overlooked or ignored in synesthesia research?

As opinionated as I am on so many topics (to which my wife, for one, would readily attest!), I have several peeves, though two stand out: The first is the tendency, still on the part of some, to think of synesthesia as some kind of abnormality. Fortunately, it seems to me that

the ever-increasing publicity that synesthesia has received in recent years has helped erase this misconception.

My other pet peeve concerns the notion, à la Charles Baudelaire's poem *Correspondances*, that synesthetic perception provides a Swedenborgian gateway to a hidden world, a pathway to a quasi-mystical alternate "plane of reality". In his case study of an individual with emotionally induced synesthesia, however, Jamie Ward (2004) has provided an alternative account: "Rather than assuming that people give off auras or energy fields that can only be detected by rigged cameras or trained seers…, we need only assume [first, that] people with whom we are well acquainted… can trigger an emotional response in the perceiver… [and, second]… that certain synaesthetic individuals have an exaggerated cross-wiring (or some other neural mechanism) between centres involved in emotional processing and colour perception" (pp. 70–71). This said, the issues here are complex and contentious (see, for example, Cardeña & Marcusson-Clavertz, 2012), so I shall not say anything more here on this topic, except to acknowledge that, despite my predilections, there is value to remaining open to multiple perspectives and analyses, hermeneutic as well as mechanistic.

How do you explain the neurological (neurophysiological) mechanisms of synesthesia if pressed for a bootstrap answer? What scientific model of congenital synesthesia based on hard data do you subscribe to?

I'm delighted that the first part of this question asks about neurological-neurophysiological mechanisms — about "mechanisms", in the plural. I'd have been even more delighted if it had asked about "mechanisms of synesthesias", and if the second part asked for something like "neurophysiological models of congenital synesthesias". If a comprehensive theory of the biological mechanisms underlying synesthesia aims to account for synesthesia/synesthesias in all of its/their forms, aspects, conditions of activation, and so forth… well… then… I suspect that such a theory will, like each of us, comprise a multiplicity. As the poet Walt Whitman wrote, in *Song*

of Myself, "I am large, I contain multitudes." Indeed, that line follows, parenthetically, the stanza's two earlier lines: "Do I contradict myself?/Very well then I contradict myself."

In your 2001 article, you and Gail Martino propose the convergent distinction of strong and weak synesthesia based on the semantic-coding hypothesis, which you later developed into the idea of a synesthesia continuum. What questions that you raised by delineating this distinction have you answered and which still remain pertinent? How do you see drug-induced synesthesia and/or synesthesia resulting from injury (e.g., an epileptic episode, a bullet wound, or a tumor) operating in this strong-weak dichotomy?

Let me start by pointing out that the distinction that Gail Martino and I made between strong and weak synesthesia is not based in an intrinsic way on the semantic-coding hypothesis. To be sure, the two notions are related, but they're related in a somewhat complex way. In an important sense, we offered the semantic-coding hypothesis as a supplement as well as an alternative to the sensory hypothesis of congruence effects in cross-modal correspondence. In our 2001 article, we noted, first that

> "According to a sensory hypothesis, congruence effects involve absolute correspondences processed within low-level sensory mechanisms. These correspondences may arise from common properties in underlying neural codes (e.g., temporal properties of neural impulses may link visual brightness to auditory pitch). This account is consistent with the sensory leakage theory of strong synesthesia and with reports that infants show cross-modal correspondences."
>
> (Martino & Marks, 2001, p. 64)

But then we continue on the same page by noting that "congruence effects involve high-level mechanisms, which develop over childhood from experience with percepts and language — an idea we term the semantic-coding hypothesis." In particular, we noted that even though cross-modal correspondences may originate in sensory

processes that are present in infancy, subsequent experience, including linguistic experience, can lead to the development of abstract semantic networks that incorporate the correspondences.

In postulating the distinction between strong and weak synesthesia and in describing the semantic-coding hypothesis, we focused on what has been termed developmental or congenital synesthesia, those instances of synesthesia that arise relatively early in life, often in childhood. The occurrences of instances of synesthesia that arise relatively later in life, after events (injury, illness) creating insults to the central nervous system, have suggested the possibility that the potential to experience some forms, at least, of (strong)synesthesia may reside more or less latent in all of us—a theoretical stance taken by Grossenbacher and Lovelace (2001), in their theory attributing (strong) synesthesia to disinhibition of otherwise inhibited neural connections that are presumably present in everyone.

In the nearly two decades since the 2001 article on strong and weak synesthesia, my work on synesthesia has mostly gone in somewhat different directions, focusing on theoretical evaluations of synesthesia's borderline conditions (Marks & Mulvenna, 2013a), multiplicity (Marks, 2014), and relation to creativity (Marks & Mulvenna, 2013b; Marks & Mulvenna, 2016). It remains my view that the semantic-coding hypothesis and the distinction between weak and strong synesthesia remain useful, especially in providing a broad conceptual framework.

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Edward M. Hubbard:

> We need to go beyond a behavioral definition, especially one that divides the world into sensory and cognitive processes, towards one based on neuroscientific processes.

Edward M. Hubbard, Ph.D., Department of Educational Psychology, University of Wisconsin, Madison, WI, USA. Hubbard's initial training was in the methods and theories of cognitive science and psychology at the University of California, Berkeley (B.A.) and the University of California, San Diego (M.A. and Ph.D.). He then held a post-doctoral appointment at INSERM in France, where he used methods of cognitive neuroscience (including functional MRI and EEG) to explore the neural basis of numerical and mathematical abilities, especially the mental number line, in typically developing adults. Inspired by the idea that the neural circuits observed in adults were the result of a lifetime of educational experiences, he took a second post-doc at Vanderbilt University, where he examined how the earliest stages of formal mathematics education shape brain circuits as children begin to link Arabic number symbols with their underlying quantity semantics during the early school years (K-3rd grade). In 2012, Hubbard became an Assistant Professor of Educational Psychology at the University of Wisconsin-Madison and at the Waisman Center, where he conducts neuroimaging studies in the emerging field of Educational Neuroscience. Hubbard is an author of multiple influential studies and publications on synaesthesia and co-editor of the fundamental edition: The Oxford Handbook of Synesthesia (2013).

How do you define synaesthesia? Is it one phenomenon or several ones?

I think it's very hard to give a clear, concise definition of synesthesia. I think of it more as a spectrum or loose constellation of phenomena. Central examples, like music-color synesthesia (chromesthesia) fit into the classical definition of synesthesia as "a stimulus in one sensory modality elicits experiences in a second, unstimulated modality". However, even commonly researched forms of synesthesia like grapheme-color synesthesia do not fit that definition well, as both graphemes and colors are different aspects of visual processing. Similarly, for forms like sequence-space synesthesia (especially number forms), the trigger is clearly more conceptual, and the associated experience is more "supramodal" or "metamodal" (above any one sensory modality), rather than being specifically visual, auditory, tactile, etc. In many ways, I like Julia Simner's (2012) argument that we need to go beyond a behavioral definition, especially one that divides the world into sensory and cognitive processes, towards one based on neuroscientific processes. In this way, we might talk about synesthesia as a form of atypical cross-map activation. This can account for forms of synesthesia that involve completely separate sensory maps, like between auditory and visual regions in the temporal and occipital lobes, different maps within the same sensory stream (graphemes and colors, both in the inferior temporal lobe) and maps that do not correspond to specific sensory modalities, like between ordered sequences and space in the parietal lobe. As such, there might be a very nice neurobiological consistency, even in the face of behavioral heterogeneity, that unifies synesthesia.

To what extent is synaesthesia inborn (genetically determined)? What are the causal influences of learning and cognition in its occurrence?

I really like Fiona Newell and Kevin Mitchell's (2016) account of how small genetic differences become amplified, and reified into the entire perceptual/cognitive system through lifelong learning and experience. Since the time of Francis Galton, there has been evidence that

synesthesia runs in families, and recent genetics studies have supported this conclusion, but it has also always been clear that learning must play a critical role. As we note in our 2001 Journal of Consciousness Studies paper, infants aren't born recognizing letters and numbers. The complex interactions between these factors require careful large-scale longitudinal studies of synesthesia, which have not yet been conducted. However, the scientific community is gaining a better understanding of how children learn to read, and how the acquisition of literacy changes brain systems in numerous ways (see Dehaene, 2009, Reading in the brain). These insights into the acquisition of reading demonstrate that there are widespread changes in the brains of literate individuals, but also note a few "hotspots" or focal points for these changes, such as in the left inferior temporal lobe, that are critical for the acquisition of orthography, and in the superior temporal sulcus, that is critical for linking orthography to phonology. These changes are surprisingly protracted, requiring more than a decade of experience with reading, meaning that a full understanding of the acquisition of (to take just one salient example) grapheme-color synesthesia will require a decade or more, following children longitudinally.

In what ways is synaesthesia an advantageous, an impeding and a neutral condition?

It is notable that synesthesia can be helpful or harmful in the same people under different circumstances. As Julia Simner and I note (Simner & Hubbard, 2013, Chapter 4), synesthetes often report that their synesthesia can help their memory, but at the same time, the color experiences can get in the way of everyday experiences. For example, with numbers, synesthetes will report that the colors can aid their memory, but can make basic arithmetic difficult, as the colors for 2 and 5 do not combine to make the correct color for 7 (to say nothing of the fact that 3 and 4 have different colors, but also should combine to make the color for 7). In general, the majority of synesthesia research that has examined this, though, suggests that the experiences are not highly advantageous or deleterious. Instead, they seem to create small differences in the perceptual and cognitive

system of synesthetes, which might simply require that synesthetes adopt different approaches to dealing with their experiences in order to function in a world where they are surrounded by non-synesthetes.

One additional note: I've long been interested in the observation that synesthetes tend to be more highly represented in "creative" professions like music. Leaving aside for a moment the issue of self-selected/self-reported samples, I'd like to mention one hypothesis that I find particularly intriguing: perhaps synesthetes have no "intrinsic" difference in their aptitude for these creative professions, but rather, because of their synesthetic experiences, they simply get more enjoyment out of, for example, Beethoven's 9th Symphony, or guitar performances from classic rock guitarist (Sean, I'm thinking of your comment, from years ago, that Jimi Hendrix, Eric Clapton, etc. elicit slightly different shades of red for you, I'm assuming because of the effects and tuning they use for their guitars). That increased enjoyment, in turn, might lead to greater motivation to spend time with (e.g.) music, and that increased motivation leads to greater practice, and therefore, aptitude.

Are people with synaesthesia special in any other way? Do all people have synaesthesia to some extent?

I'm not convinced that people with synesthesia are special in any other ways. I think that we need studies that use really large-scale random sampling to test a whole variety of different possible effects. The most common example is that many early studies suggested that synesthesia was more common in women than in men, but proper random sampling demonstrated that there is almost no difference in the prevalence of synesthesia in men and women (Simner, Ward et al., 2006). Hence, I think that we have to be very careful of any claims that synesthesia, in general, is associated with specific differences.

As for whether we're all synesthetes, we have famously (and provocatively) argued that cross-sensory correspondences that are present in everyone are a form of synesthesia (e.g., Ramachandran & Hubbard, 2001). Recent studies have even demonstrated that some of these cross-sensory correspondences are present in non-human primates

(e.g., Ludwig, Adachi, & Matsuzawa, 2011; Dahl & Adachi, 2013), suggesting that they are not simply a matter of linguistic regularities. Hence, we have argued that the principles revealed through the study of synesthesia highlight regularities that govern perceptual and conceptual systems in everyone. Indeed, we've gone even further to argue that weaker versions of the same neural wiring that gives rise to synesthetic experiences in a subset of the population might also be responsible for the conceptual rightness that non-synesthetes experience for these same cross-sensory mappings. However, it should also be stressed that non-synesthetes do not have the overt conscious experiences that synesthetes do. Perhaps this is simply due to differences in the strength of the wiring between these different perceptual and conceptual maps, but it might also reflect differences in other brain systems.

What is your story (and impression) of reading Alexander Luria's *The Mind of a Mnemonist*?

It must have been 1992 or 1993, and I had been given a copy of Richard Cytowic's book, *The Man Who Tasted Shapes*, by my calculus professor, Egl Batchelor, at Chabot College in Hayward, CA. I was attending Chabot, doing my General Ed. coursework, before eventually transferring to UC Berkeley, and Batchelor was one of the professors who really helped me on my way. I started reading *The Man Who Tasted Shapes*, and Cytowic introduced me to Luria's book and his incredibly detailed observations of Shereshevskii's synesthesia and memory. I was so fascinated that I tried to look up a copy of the book, only to discover that the only local copy was at the Berkeley public library. I got the train from Hayward to Berkeley that night, got a Berkeley public library card, and promptly checked it out. I read almost the entire book in one sitting that night. I was so impressed with the combination of detailed clinical observations, experimental studies, neurological theorizing, and personal empathy for Shereshevsky life, that the entire experience has stayed with me for the past 25 years. It influenced the course of my entire academic career, leading me to work with a similarly gifted neurologist/experimentalist/theorist

in V.S. Ramachandran for my graduate studies, where we collaborated on studies of synesthesia for over a decade. And, to this day, I recommend it as one of the few "must read" books for my graduate students who study synesthesia. In my own work, I often return to it for inspiration and for Luria's deep reflections on psychology and neurology.

Why is it important to do research into synaesthesia? What are its promises for cognitive science or science at large?

I think it's important to study synesthesia because it helps to illuminate the varieties of human cognitive and perceptual experiences. It also demonstrates how (likely small) genetic variation can lead to profound differences in people's lives. By better understanding the genes that build brains, how differences in those genes lead to differences in perceptual and cognitive experiences, and how those differences in turn affect people's entire lives, I think that we can gain a much deeper understanding of the things that make us human.

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Jamie Ward:

> The relationship with synaesthesia points more towards aspects of autism linked to talent, for example, attention to detail, than those linked to impairment although both are inflated to different degrees.

Jamie Ward is a Professor of Cognitive Neuroscience in the Department of Psychology at the University of Sussex; he also serves as Co-Director of Sussex Neuroscience, and is on the faculty of the Sackler Centre for Consciousness Science. He received his Ph.D. from the University of Birmingham. He is a Founding Editor of *Cognitive Neuroscience*, a quarterly peer-reviewed academic journal published by the Taylor & Francis Group. Jamie Ward conducts research in human cognitive neuroscience using methods such as neuropsychology, fMRI, TMS and EEG. The specific focus of his present research can be divided into three interrelated strands that all relate to individual differences in perceptual experience, and the relation between perception and other aspects of cognition (including memory and social cognition). His research group is one of the world-leading centres for studying the phenomenon of synaesthesia (hearing flashes, tasting words, coloured music, etc.). The research is revealing how individual differences in conscious perceptual experiences are linked to neurobiological differences and how they relate to cognition more broadly. He is author of the book on synaesthesia *The Frog Who Croaked Blue: Synesthesia and the Mixing of the Senses* (2008) and multiple influential articles on the phenomenon, the topics of which span from creativity and memory to emotional mediation and haptic perception in congenital synaesthetes.

How do you define synaesthesia?
Is it one phenomenon or several ones?

For me, synaesthesia has the following three defining characteristics:

1) It consists of an inducer (something that triggers the synaesthesia) and a concurrent (the resulting synaesthetic experience); that is, there is an associative element to synaesthesia;

2) The synaesthetic experience (or concurrent) is consciously experienced (i.e., an implicit association is not synaesthesia) and it has percept-like qualities. The latter includes mental images as well as true percepts;

3) The elicitation of the concurrent is involuntary. I have deliberately used the term involuntary in place of a term that I previously used, namely 'automatic'. Other researchers have rightly pointed out that the term 'automatic' has other associated meaning (e.g. that it occurs inevitably). Synaesthesia can be involuntary without being inevitable (e.g., depending on whether attention is given to the inducer).

For me, all phenomena that meet these criteria could potentially be classed as synaesthesia, although whether this actually helps to explain the phenomena I am not so sure. For instance, attempts to train people to have synaesthetic experiences would meet the above definition of synaesthesia, but I don't know how helpful it is for explaining the naturalistic emergence of synaesthesia. One could think of this training as creating a 'phenocopy', in biological terms. I don't conflate the definition of synaesthesia with the causes of synaesthesia, because synaesthesia may have multiple causes. However, there clearly are far more types of synaesthesia than there are causes (i.e., no one-to-one relationship). For instance, most synaesthesias of developmental origin tend to co-occur within individuals (i.e., they have multiple types) and there aren't well-documented instances of family trees in which only one type of synaesthesia predominates.

To what extent is synaesthesia inborn (genetically determined)? What are the causal influences of learning and cognition in its occurrence?

It is hard to think of any psychological traits/conditions that are genetically determined in the way that this question seems to imply (i.e., that synaesthesia will emerge inevitably given the presence of a particular genotype). For instance, if one looks at autism and schizophrenia, which have had a huge research effort dedicated to them and are widely believed to have a strong genetic component, only 1–2 percent of cases appear to be 'genetically determined' whereas the other 98-99 percent may be 'genetically predisposed' (i.e., carry a genetic vulnerability, but these genes are not unique to people with the condition and occur widely in the neurotypical population). I suspect synaesthesia is similar (but I am not trying to pathologise synaesthesia with this analogy; I am just drawing on knowledge from elsewhere). I am not trying to dismiss the role of genetics, as I think it is really important, but it may be complex and entail a degree of randomness. For instance, certain combinations of genes may cause the brain wiring in region X to proliferate more than in other people (but the extent of proliferation could be a normal distribution). If the degree of proliferation is above a certain level, then this person may go down the developmental trajectory of having synaesthesia; whereas, if it is below a certain level, that person may not. But these two people could have the same genotype, just expressed in slightly different ways. I am not sure what learning events are needed, and I have wondered for decades what synaesthesia would be like in people who never learn written letters and numbers: would they even have synaesthesia at all? Or would it manifest in other ways?

In what ways is synaesthesia an advantageous, an impeding and a neutral condition?

Here it is very important to make a distinction between synaesthesia (as I have defined it) and other traits that are linked to synaesthesia (e.g., because of wider changes in brain or cognitive development that often go hand-in-hand with synaesthesia). In general, my view is that synaesthesia is a neutral condition insofar as the synaesthetic experiences themselves are rarely informative (i.e., carry information over and above the inducer itself) and rarely adverse or distracting. There

may be interesting exceptions to this, but this would be my overall summary. With regards to traits linked to synaesthesia, my view is that these traits are, on the whole, cognitively advantageous. These include greater mental imagery, enhanced memory, certain perceptual abilities, and perhaps enhanced creativity. These could be said to constitute an endophenotype of synaesthesia, but further research is needed on that (e.g., looking at these traits in other family members). But note that it isn't a direct product of having a synaesthetic concurrent. Thus, people with coloured words not only have better memory for words (their inducers) but for many/most non-inducers too. To some extent, I think of synaesthesia as one symptom of a broader constellation of tendencies. I have previously likened synaesthesia to a 'colourful sideshow' but I am not trying to denigrate the experiences of synaesthetes with this phrase (their experiences are rich, personal and often beautiful). What I am trying to do is draw attention to the 'main stage', which is where the important cognitive advantages lie. There are some potential downsides to synaesthesia—both our group and other researchers have shown a link between synaesthesia and autism. However, even here, the relationship with synaesthesia points more towards aspects of autism linked to talent, for example, attention to detail, than those linked to impairment, although both are inflated to different degrees.

Are people with synaesthesia special in any other way? Do all people have synaesthesia to some extent?

I hold to the view that synaesthesia versus non-synaesthesia is a categorical distinction. It may be possible to have 'synaesthesia genes' and not be synaesthetic but I would classify this person as a non-synaesthete (not a half synaesthete). The same would hold true even if they had other traits that tend to go with synaesthesia. There are differences within synaesthetes themselves: for instance, some synaesthetes have one kind and other synaesthetes have multiple kinds. It is possible to say that this second person is more synaesthetic than the first, and this may indeed be meaningful (e.g., we show that the more kinds of synaesthesia a person has is relevant to their autistic

tendencies), but I would draw a categorical boundary between people who have synaesthesia and those who do not. The best way I can illustrate this is through the figure below.

What is your story (and impression) of reading Alexander Luria's *The Mind of a Mnemonist?*

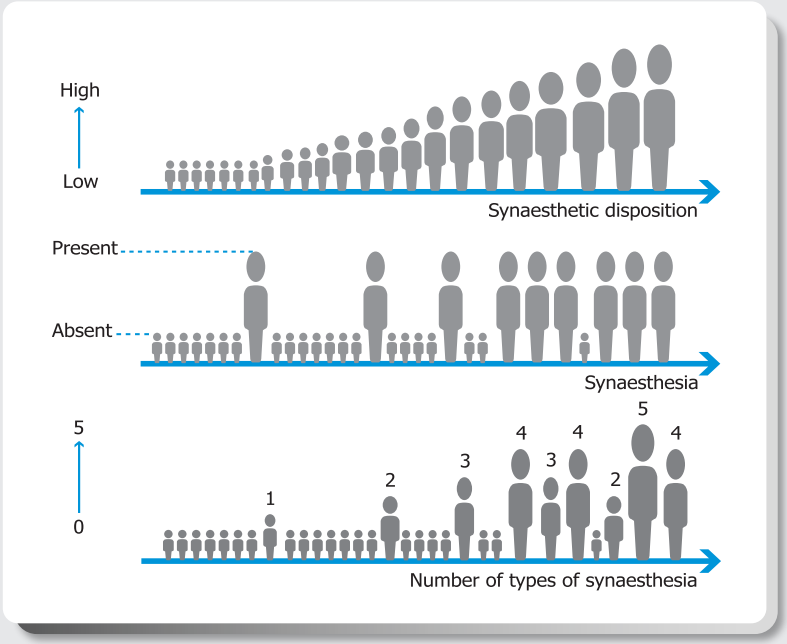
This was very influential to me and it started a whole line of research exploring synaesthesia and memory (my first paper on this was called *Searching for Shereshevskii*). Shereshevskii isn't a typical case of synaesthesia though, but it doesn't stop this book from being interesting and valuable. His memory ability was beyond our capacity to measure it, but other synaesthetes have a more subtle memory advantage (about 0.6 standard deviations above the non-synaesthete mean). But this would impact on 'real world' memory abilities and, given the non-linear shape of the normal distribution, it means that synaesthetes will be greatly over-represented at the high end of the tail.

Why is it important to do research into synaesthesia? What are its promises for cognitive science or science at large?

I think synaesthesia forces us to reconsider how we conceptualise individual differences and what it is to be 'normal'. Synaesthetes are normal (despite being statistically rare), but it is a different kind of normality to that experienced by others: their first-person experiences are fundamentally different, as are their cognitive abilities. Rather than thinking of individual differences as a continuum, we should think, instead, of a 'lumpy' space of different ways of being. By studying synaesthesia, we get clues as to different ways in which minds and brains can be constructed rather than assuming that a single way fits all.

Being a non-synaesthete yourself, would you want to have synaesthesia? If so, which type of synesthesia would you most like to have, towards doing research on yourself?

Yes, I would love to have visual experiences to music — preferably in my mind's eye. In fact, I'd love to have a mind's eye because I am not even sure that I have that. I don't think in visual terms.



A synaesthetic disposition (consisting of a characteristic genotype and neurocognitive profile) increases the likelihood of synaesthesia emerging (people have it or not) and increases the likelihood of different kinds of synaesthesia emerging (some synaesthetes are more extreme than others). Provided by Jamie Ward

Do you know of any studied relationships between synaesthesia and risks of developing cognitively atypical conditions, e.g., epilepsy, or forms of autism? What do you think of such possible relations?

Yes, there are two studies showing that people with a diagnosis of autism are more likely to have synaesthesia. It suggests that there are some common aspects to them — but it doesn't show (in any way) that they are the same thing. They are clearly different.

To prove synaesthesia as one manifestation of a wide range of tendencies, your study shows several of such neurocognitive differences – in different types of memory, visual imagery and various aspects of visual perception. Moreover, despite calling synaesthesia a "sideshow", you conclude, for example, that synesthesia enhances sensory memory "only when subjective clarity of the target letter is high" and test-retest consistency of synaesthesia is more stable. How do you now disentangle the causal interactions of synaesthesia-related individual differences in attention, sensitivity, perception, memory and synaesthesia?

If we find cognitive differences that are common across synaesthetes (irrespective of the pattern of inducers and concurrents), then this is evidence that there is something linked to synaesthesia per se (rather than the specific manifestation of synaesthesia). For a more detailed discussion of this you can read Ward (2019) in *Philosophical Transactions of the Royal Society*. This is a good reflection of my current thinking about synaesthesia and is probably going to be more helpful than focussing on these quotes (which might reflect the views of my co-authors more than myself).

What is your current "pet peeve" most annoying misconception about synaesthesia? What ideas about synaesthesia has your experience of researching synaesthesia made you get rid of? What do you feel is the main thing currently being overlooked or ignored in synaesthesia research?

I am not sure I have a pet peeve. In terms of moving forwards, I do think we need to start thinking about synaesthesia more broadly and not focusing narrowly on grapheme-colour synaesthesia.

Jean-Michel Hupé:

> At some point, though, synesthetic experience could become a benchmark of the sensitivity of tools and methods.

Jean-Michel Hupé, Ph.D., is a research scientist at the French National Scientific Research Centre (Centre national de la recherche scientifique, CNRS). Hupé obtained a Ph.D. in neurosciences in 1999 in Lyon, France, with Jean Bullier on the role of feedback connections in motion perception, studying visual perception with electrophysiological methods. Then, he trained in psychophysics and brain imaging methods at New York University, specializing in the bistable perception of ambiguous stimuli. He has been working at the Brain and Cognition Lab (Centre de Recherche Cerveau et Cognition (CerCo), Université de Toulouse Paul Sabatier and CNRS) in Toulouse since 2002, studying synaesthesia since 2006. In collaboration with Michel Dojat, Jean-Michel Hupé studied grapheme-color synaesthesia extensively using phenomenological reports, psychophysics, functional and structural MRI, seriously challenging the most accepted facts, universal methodological stances and widely held beliefs in neuroimaging and neurophysiological research of synaesthesia. In his papers, Hupé tried to promote a rigorous usage of statistical tests, and to propose alternatives when validity conditions were not met. With an interest in methodological and statistical issues, he has been quite disappointed, like many others, by the poor standards in cognitive neurosciences. He is now shifting to the field of political ecology.

How do you define synaesthesia?
Is it one phenomenon or several ones?

Synesthesia is a "peculiar habit of mind" (Galton, 1880), in which, as a first approximation, "one attribute of a stimulus (e.g., its sound, shape, or meaning) [the inducer] may inevitably lead to the conscious experience of an additional attribute [the concurrent]" (Ward, 2013). Synesthesia refers to particular subjective experiences, to a family of phenomena that we may define as sharing a common set of properties: synesthetic experiences are additional, involuntary (they are not evoked at will and are not chosen, contrary to metaphors), arbitrary and idiosyncratic associations (Hupé, Bordier, & Dojat, 2012; Hupé & Dojat, 2015). Synesthetic associations are emotionally loaded with a feeling of evidence (Hupé, 2012a). They are typically uni-directional, the inducer triggering the concurrent experience.

The prototypical synesthetic experience in the XIX century was "audition colorée" (sounds triggering color experiences), hence referring to the etymology of syn-aesthesia, even though synesthetic experiences do not necessarily involve senses sensu stricto. For example, numbers can be imagined within a particular mental space or associated with gender or personalities, two forms of synesthesia (according to our definition) that may be encountered the most frequently (Flournoy, 1893; Chun & Hupé, 2013). Mirror-touch and ticker tape are other subjective peculiarities sharing several characteristics with synesthesia, but they are minimally idiosyncratic and not arbitrary (Chun & Hupé, 2013).

Deciding whether synesthesia may refer to a unique phenomenon or not would require finding its cause at a genetic, developmental or neurological level. There is no solid evidence so far that synesthesia is a neurological condition, meaning being due to a structural or functional brain anomaly (Hupé & Dojat, 2015; Dojat, Pizzagalli, & Hupé, 2018). The analysis of co-occurrence of synesthesia types revealed that, even if considered as a unique phenomenon, synesthesia has several varieties (Novich, Cheng, & Eagleman, 2011).

The objective phenomenological description of those atypical subjective experiences remains challenging, while there is no definitive,

objective test of synesthesia. Even the test/retest of associations, methodologically convenient for researchers, has its limits: some persons with many memorized associations may report no subjective experience of synesthesia, while others may report too few synesthetic associations to be convincing at a statistical level. The need of an arbitrary statistical criterion is especially problematic for children, who seem to have much fewer associations as well as description modes different from adults (Simner & Bain, 2013; Simner et al., 2009; Garnier, 2016). Subjective reports are still, like in the XIX century, the richest source of information. Their diversity questions the unicity of the phenomenon. Some synesthetes experience those associations as anecdotal with a minimal impact on their life, while for others they can be overwhelming. The strength of associations was proposed by Flournoy (1893) as a useful guide for classification. The strength of interferences in Stroop-like tests constitutes an objective though approximate measure, at least for some types of synesthesia like the most studied grapheme-color type (Ruiz & Hupé, 2015).

To what extent is synaesthesia inborn (genetically determined)? What are the causal influences of learning and cognition in its occurrence?

As for any behavior, the nature/nurture distinction is an ill-posed problem. Synesthetic experiences can certainly not be entirely genetically determined, since most types involve written language that has to be learnt quite late in life. The proposal that "we are all born synesthetes" does not hold, not only because there exists no direct evidence in favor of this proposal, but also because the supposed "fusion of senses" at birth is not equivalent at all with specific associations between individualized senses. There is certainly not any single gene responsible for synesthesia, but, as for about any behavior, specific genetic patterns may favor or hinder the development of synesthesia. A study on twins (raised together) reveals that even monozygotic twins do not always both have synesthesia (Bosley & Eagleman, 2015). Most do, but same sex dizygotic twins as well. As long as there exists no strong evidence for alternative causes, the simplest explanation for synesthesia involves

learning (Witthoft & Winawer, 2013; Witthoft, Winawer, & Eagleman, 2015), even though the sources of the associations may be multiple and change over the course or their acquisition (Ward & Simner, 2003; Hupé 2012b; Hupé & Dojat, 2015) during late childhood (Simner et al., 2009; Simner & Bain, 2013; Garnier, 2016). We proposed that synesthesia may be considered simply as "a special kind of childhood memory" (Hupé, 2012a, 2012b; see the last paragraph by Hupé and Dojat, 2015 for a detailed account of this proposition).

In what ways is synaesthesia an advantageous, an impeding and a neutral condition?

Based on both subjective reports and experiments, there is no systematic benefit or disadvantage of synesthesia. For most synesthetes who reported to me, synesthesia would rather be a "neutral" condition. But many synesthetes enjoy their synesthetic associations, a few of them use them to remember phone numbers or dates, while a few others are overwhelmed by a surcharge of meaning.

Are people with synaesthesia special in any other way? Do all people have synaesthesia to some extent?

Most if not all people are special, and listening to synesthetes is an opportunity to enter into the rich diversity of subjective experiences. But there does not seem to exist any strong association between synesthesia (as a whole) and any personality trait or cognitive faculty or performance, or creativity (Chun & Hupé, 2016), contrary to what is often reported, sometimes even misreporting our results: we did find that our measures were compatible with weak associations, in particular with the absorption and openness personality traits, but we did not have convincing evidence that, overall, synesthetes were different from control subjects; recruitment bias was impossible to rule out completely, and it was striking that, within our sample, differences between men and women were larger than between synesthetes and controls.

Even though there is a continuity of experiences between synesthetes and non-synesthetes (Price & Pearson, 2013), and many people do not realize that they are making synesthetic associations before

being asked about them, not all people have synesthesia. Our estimates are however close to about 20% of the population who may have at least some weak form of synesthesia (Chun & Hupé, 2013).

What is your story (and impression) of reading Alexander Luria's *The Mind of a Mnemonist*?

This is a great though sad story. Shereshevsky is certainly not your typical synesthete, though I did record a couple of synesthetes for whom it seemed that all senses communicated with each other in ways evoking the experience of Shereshevsky (and who suffered from it). The story shows how one may build up some kind of advantage (memory) by training strategies based on one's particular ability.

Why is it important to do research into synaesthesia? What are its promises for cognitive science or science at large?

I am not sure anymore that it is important to do research into synesthesia, while it is still important to make known that synesthesia exists and is not a pathology. One promise for cognitive science was an entry into studying the neural correlates of the subjective experience: subjective reports are clear enough to assess that the subjective contents of the experience of synesthetes and non-synesthetes are different for some stimuli. Studying synesthetes could be considered as doing neuropsychology on non-pathological people. With color being the most often reported concurrent experience, there was also a promise to better understand the neural construction of color experience. Functional MRI was supposed to reveal the neural correlates of the synesthetic experience of colors. Contrary to many claims and published results, those correlates have remained elusive (Hupé, Bordier, & Dojat, 2012; Hupé & Dojat, 2015), this literature illustrating the many pitfalls of MRI research (Hupé, 2015). Even by applying Multivariate (multivoxel) Pattern Analysis (MVPA), we did not find any evidence of shared patterns of activations by real and synesthetic colors, as well as no strong evidence of differences between synesthetes and controls (Ruiz, Dojat, & Hupé, 2017). Future technological developments may allow some identification of the neural correlates of synesthetic experiences; but, until then, it is not so clear what would be gained from those results.

You stated that synaesthesia is the result of spontaneous associative learning or "memories of a special kind" (Hupé & Dojat, 2015). How could we see drug-induced synaesthesia and/or synaesthesia resulting from injury operating in this system or differing from congenital synaesthesia? How does this work regarding synaesthetes being surprised with their first encounter with specific synaesthetic concurrents, for example, a first-time experience with touch-to-flavour synaesthesia or the classic story of "orange sherbet kisses", where the girl was startled by her experience?

I did not study drug-induced synesthesia nor synesthesia resulting from injury. I agree that the proposition of synesthesia being the result of associative learning could seem hardly compatible with those cases. Even though drugs and injuries may elicit forgotten memories, those phenomena may differ indeed. Or further research along those lines might show that the associative learning hypothesis is not valid. My impression, in particular after interviewing a colleague having experienced synesthesia with Ayahuasca during his field research in anthropology, is that the phenomenal content of drug induced synesthesia is very different from what I have been studying. On the other hand, synesthesia experiences involving a strong connection with emotions, like in the "orange sherbet kiss" example, may also challenge the memory hypothesis. Or would require to reframe it differently, since memory and emotions do have strong links. The question at stake here, maybe, and which has been raised quite often, is the possible link between the "madeleine de Proust" and, say, grapheme-color synesthesia—with the orange sherbet kiss experience in between.

You estimate that "there are about 20% of the population who may have at least some weak form of synesthesia." What do you mean by people having "weak" forms of synaesthesia?

This term should be operationalized indeed. For grapheme-color synesthesia, this corresponds to low values of the index of synesthetic strength, as measured with variants of the Stroop test (Ruiz & Hupé, 2015). This corresponds therefore to weak associations.

On the phenomenological level, I do not have any systematic criterion because I never had to use it. But I would use this category informally for synesthetes for whom synesthesia has very little impact on their subjective experience. For example, synesthetes who have only a few associations. Those synesthetes may comply with phenomenological criteria but not quantitative ones based on a statistical cut-off. Or synesthetes who would report that the synesthetic associations do not arise spontaneously: they have to think to become aware of them. This happens quite often for the gender of numbers: if asked about them and after giving some thought about it, some people would tell me something like 'I had never thought about it, but now you're asking I realize that yes, 2 is masculine and 3 is feminine, I don't know why but it's like that". Grapheme-color synesthetes having to think that way to retrieve the color of numbers or letters have low scores for the index of synesthetic strength. Other typical statements corresponding to what I loosely call weak synesthesia go like this: "The days of the week have specific colors but I am not a synesthete because I must simply remember the colors from my classroom when I was a kid". The synesthete who made this precise statement had to think to retrieve the colors of some of the days, and, then, she was confused because she realized that Thursday and Friday were both green, which was not compatible with her explanation of a classroom calendar (since days are supposed to have different colors to help children to remember the names).

You state that you are "not sure anymore that it is important to do research into synesthesia" adding that "[c]ontrary to many claims and published results, those correlates have remained elusive" (Hupé, Bordier & Dojat, 2012; Hupé & Dojat, 2015). Can synaesthesia, being, for instance, a model case for awareness/consciousness manifestation, help towards improving the methodological pitfalls of neuroscientific tools and techniques?

I would rather suggest that the methodological pitfalls of neuroscientific tools and techniques should be overcome before further

neuroimaging research on synesthesia be done. We have tried to contribute to this aim by applying MVPA and the use of confidence intervals (Ruiz, Dojat, & Hupé, 2017). But, to our surprise, despite the clear difference of phenomenology between the synesthetic and non-synesthetic subjective experiences, we did not observe any physiological difference strong enough to be convincing. This suggests that the signals are weak. Weak signals are probably not the best choice to improve measuring tools, because they involve uncertainty and circularity about what we measure. At some point, though, synesthetic experience could become a benchmark of the sensitivity of tools and methods.

Being a non-synaesthete yourself, would you want to have synaesthesia? If so, which type of synesthesia would you most like to have, towards doing research on yourself?

Not really. I would not mind either, but I do not see why I should want to have synesthesia. Some synesthetes get quite boring when talking so much about their associations! For a while, I was very curious about the so-called projector-type of grapheme-color synesthesia, when I was still considering the possibility that for some synesthetes this may almost correspond to hallucinatory perception. But the associator-projector distinction does not seem valid anymore. Also, I had met a young researcher on synesthesia at a conference, who considered himself a "projector" synesthete. During the conversation, we realized that his subjective experience did not help him understanding "objectively" what he meant by that. I had other very long conversations with grapheme-color synesthetes with very strong associations, as measured with the modified Stroop test, rich phenomenology and a good understanding of the scientific questions. During such a conversation, one of them was trying to understand what is was like not being a synesthete. I asked her whether she had synesthesia for Greek letters. She did not, but she had this "aha" revelation. She was able to understand subjectively both experiences. I'm not. So be it, and let's forget about trying to cross the frontier of subjectivity with scientific so-called objective methods. Literature is so much better at that!

You write that, "[a]s long as there exists no strong evidence for alternative causes, the simplest explanation for synesthesia involves learning, even though the sources of the associations may be multiple and change over the course or their acquisition" (e.g., Hupé & Dojat, 2015). If we have not yet found sufficient evidence of neurological causations, is there anything about the phenomenon that should or might still make us keep looking?

There is definitely some enigma about synesthesia, even if considered just as a "special case of childhood memory". One question is why only some people have it? Both genetic and neurological explanations could be valid and not necessary contradictory with the memory hypothesis, since they address different levels of causality. The other question is about the "special". Those memories would be special in the sense that the feeling of evidence may derive from having forgotten the origin of the associations but not the associations themselves. But, in a sense, this is not so special, since we could apply such a description to most prejudices and beliefs (like the belief in God from childhood, or the belief in p-values from Statistics 101: Hupé, 2015). In any case, there is definitely something to explain about synesthesia, so we certainly could keep looking for possible neurological causation. To this end, since neurological differences if present would be subtle, the sharing of raw MRI data seems the very best option (Dojat, Pizzagalli, & Hupé, 2017).

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Romke Rouw:

> Currently, really interesting discussions are going on, connecting synesthesia research with other areas of research. I feel this is showing the growth of our field and progress we have made.

Romke Rouw, Ph.D., studied Psychology at the University of Amsterdam, the Netherlands, and received her Ph.D. in 2001 from Tilburg University. During her doctoral thesis (with Prof. Beatrice de Gelder), she studied the 'special' processes involved in face recognition. In 2001, she returned to the University of Amsterdam as faculty member in the group Brain and Cognition in the Psychology department. She currently teaches graduate and undergraduate courses, gives lectures to academic and non-academic audiences, has management functions in the Department of Psychology, University of Amsterdam, and performs cognitive and neuroscience research. Her research is on perception and sensations, with a particular fascination for the surprisingly loose relationship between the stimulus input from our physical environment on the one hand, and the rich sensations in our private mental world on the other. This is not only the case for 'special cases' such as synesthesia; during a one-year visit to the lab of Professor Kosslyn at Harvard University, she examined the similarities between visual percepts and visual mental images. She currently studies the cognitive and neuroscientific mechanisms underlying extraordinary sensations. She finds synesthesia a great example of how 'different' sensations do not need to be 'bad'! She is a visiting scholar at the University of California, San Diego, since 2011.

How do you define synaesthesia? Is it one phenomenon or several ones?

In synesthesia, a particular sensation or experience evokes another particular sensation or experience. The synesthetic additional experience ('concurrent') is not easily explained by the properties of the initial experience ('inducer'). Synesthesia is not explained by, or part of, a psychological or psychiatric 'disease'. Indeed, synesthetes often report to find their synesthesia pleasant and useful. There are many subtypes of synesthesia, meaning different types of inducer-to-concurrent combinations (Day, 2005). A well-known subtype is grapheme-color synesthesia, where a small linguistic element (e.g., a letter, a number) can evoke a particular color. Other subtypes are colors with music, or numbers/letters in a spatial orientation (spatial sequences). Synesthesia 'runs in the family'; if you have synesthesia, it is likely you can find a family member with synesthesia (Barnett et al., 2008). However, the family member will probably have different inducer-to-concurrent associations. He or she might even have a different subtype of synesthesia (you see colored letters while your father experiences colors with musical instruments). Also, types of synesthesia 'cluster together': you are more likely to have a less common type of synesthesia (taste to words) if you already have a more common type of synesthesia (colored letters) (Novich et al., 2011). For these two reasons, I believe there is one condition "synesthesia", with different subtypes. To what degree subtypes are similar or different is yet a question. For example, does the 'projector-associator' distinction exist in other types of synesthesia?

To what extent is synaesthesia inborn (genetically determined)? What are the causal influences of learning and cognition in its occurrence?

This is one of the fascinating questions we are working on as synesthesia researchers! In the larger scientific field of Cognitive Neuroscience, we study the relationship between mental functions and the structure and functioning of the human brain. The relative roles of learning versus genes is one of the main questions in this field (Brang

& Ramachandran, 2011). Synesthesia research offers an extraordinary window into addressing this question. I personally believe that there is a synesthetic predisposition: you can be born with increased probability to develop synesthesia (Simner & Bain, 2013; Tilot et al., 2018). However, which type of synesthesia you develop depends upon your environment. So, in a class of children, some children will be more likely to develop synesthesia, for example, because their brains are more prone to form additional brain connections (Rouw & Scholte, 2007).

In what ways is synaesthesia an advantageous, an impeding and a neutral condition?

This should be answered by synesthetes personally. It might also differ between individuals. From what I have learned from conversations with the many synesthetes visiting my lab, the great majority of synesthetes enjoy their synesthesia; they find it pleasurable and useful. A synesthete could pity the non-synesthetes for their boring world. However, synesthesia can also have its disadvantages. If a child thinks he or she is 'different', this can make him or her feel bad (of course, this really is a problem from the social environment, not really listening to or accepting someone's personal experiences)! Synesthetes can also feel bothered or annoyed, if there is an incongruence between what happens in the outside world and their personal synesthetic experiences. I enjoy giving presentations to teachers at schools, and try to show how beneficial it can be to take individual differences in cognition (in particular synesthesia!) into account when creating a learning environment.

Are people with synaesthesia special in any other way? Do all people have synaesthesia to some extent?

One of the reasons I love studying synesthesia is that synesthetes shows that 'different' does not need to be 'bad' or 'ill' or 'sad' or any other negative connotation (see my previous answer). I do believe synesthetes are 'different'. In their experiences and sensations, in the way their brains develop in early childhood, in the way they respond to influences in their environment. I believe this because synesthetic experiences are really different from more general multisensory

associations or metaphors. Synesthetic associations are highly specific, consistent, and synesthetes are aware of them without having to do a lot of effort or 'trying to remember'. Synesthetic experiences are 'different' in being 'real' (percept-like); you can ask a synesthete what is the exact synesthetic color of the letter "R", but you cannot ask a non-synesthete 'green with envy' which exact green color is his envy. The nature of the experiences sets synesthesia apart from other types of (cross-modal) associations.

Can non-synesthetes be trained to become synesthetes? Perhaps! (See Colizoli et al., 2016; Rothen et al., 2018). On the other hand, perhaps there is a limit to which a non-synesthete can be trained. I believe scientific research will elucidate this fascinating issue in the near future!

What is your story (and impression) of reading Alexander Luria's *The Mind of a Mnemonist*?

Professor Luria is a distinguished psychologist and a founding father of contemporary neuropsychology. His careful observations and beautiful writing style make this book a literary work as well as scientific accomplishment. In my opinion, this study is a leading example on how much can be learned from the 'special cases' of extraordinary brain functioning. Luria's detailed descriptions offer insight on the rich inner mental world of Solomon Shereshevsky. These descriptions show how there is never just "one side" to exceptional mental functioning, and portray both advantages and disadvantages. *The Mind of a Mnemonist* is not the only Russian contribution to an in-depth understanding of synesthesia! Another famous example is Vladimir Nabokov's description of his "colored-hearing" synesthesia (*Speak, Memory, 1951*).

Why is it important to do research into synaesthesia? What are its promises for cognitive science or science at large?

There is a lot I could say here, but I will restrict myself to just a few sentences. Synesthesia is a 'special case' of human cognition and aids our understanding of the mechanisms underlying the generation of rich, private, and subjective experiences. It offers extraordinary

opportunities to understand human (brain) functioning, and it teaches us how 'different' can be just 'different'; interesting by itself rather than needing any moral connotations of 'good' or 'bad'.

What do you currently consider to be the most annoying misconception about synaesthesia? What ideas about synaesthesia has your experience of researching synaesthesia made you get rid of? What do you feel is the main thing currently being overlooked or ignored in synaesthesia research?

Currently, really interesting discussions are going on, connecting synesthesia research with other areas of research. I feel this is showing the growth of our field and progress we have made. One example is the research on the relationship between synesthesia and other conditions, such as autism spectrum disorder. Another example is research on the genetic associations with synesthesia, and the continuing discussion on the degree to which synesthesia is just a 'special case' of multisensory integration.

One thing I would really like to keep, and feel sometimes is forgotten, is that we already formed a definition and formulated the characteristics of synesthesia. To make sure we all keep talking about the same condition, and to be able to connect new research with previous research, it is important to all stick to that definition.

You and Scholte (2016) examined personality traits in synaesthetes by attempting to look at a large cross-section of Dutch people with as many different types of synaesthesia as possible. Hypothetically, if this type of study could be expanded worldwide, to encompass thousands of different, diverse cultures, can you speculate upon what we might expect to find as global universals regarding personality traits of synaesthetes?

This is a very interesting question. It is difficult to answer, as the research has not actually been done. It would be interesting and important to include more different countries and different cultures in synesthesia research. This is not easy to do, but an organization with explicit internationalization aim such as IASAS can play an important

role in this process. While it is speculation, I would predict that, from the 'big five' personality characteristics, increased "Openness" (Openness to Experiences) is related to synesthesia. Currently, this personality characteristic has been found related to synesthesia in several studies in in different countries. Of course, the directionality of this link is not yet clear: does openness to new experiences enhance the development of synesthesia? Or, once you have the additional synesthetic sensations, this helps you develop more 'openness' in your personality? Another very interesting characteristic to investigate in different cultures and countries is the slight increase of IQ we and others obtained in synesthetes, as compared with non-synesthetes.

Is this finding actually pointing at a fundamental difference, (e.g., in development of cognitive skills), or not?

As you and many others have pointed out, the overwhelming majority of research on synaesthesia focuses on linguistic aspects as the inducer, and colour as the concurrent; many other types of synaesthesia are rare, and it is difficult to find a valid number of subjects. If it were possible to have a large set (e.g., well over 200) of participants with any particular, specific type of synaesthesia available at your lab for experimental research, which one type of synaesthesia do you think would currently give us the most valuable and needed new insights. What experiment(s) might you wish to run on this group of participants?

It is possible that we do not find all the other types of synesthesia because we do not search for them! In one study (Rouw & Scholte, 2016), we aimed to learn more about all the different types of synesthesia; we asked 368 subjects about their experiences. We had a representative sample of the Dutch population: the recruitment procedure was set up to counter a selection bias or a self-report bias in our subject group. Many different types of synesthesia were included, following the categorization as used by Novich et al. (2011): Colored Sequences, Colored Music, Colored Sensations, Spatial Sequences, Non-Visual Sequelae, as well as an additional synesthesia type,

Sequence-Personality. One remarkable result when including all sorts of synesthesia is that the prevalence sharply increases and synesthesia becomes much more common than is currently assumed. Rather than one particular type of synesthesia, I would like to do another large study including all the different types of synesthesia.

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Michael Banissy:

> Learning how these interactions vary between us, as in mirror-sensory synaesthesia, can therefore provide a powerful opportunity to gain unique insights into the functioning of empathy in us all.

Michael Banissy is an award-winning Professor in Psychology (Goldsmiths, University of London), with a specialism in Social Neuroscience. He has contributed to several diverse research areas, including social perception, social cognition, creativity, synaesthesia, and brain stimulation, where he has made a number of important discoveries. He is perhaps most well-known for his work on mirror-touch synaesthesia, where he is recognised as a leader in the field. Michael has received external grant funding from a variety of organisations to support his work including. He received the 2016 Spearman Medal and 2017 Bertelson Award (two of the highest accolades given to Psychologists) for outstanding contributions to psychological research. Michael has worked extensively to support science communication and the application of psychological insights to the real world. Some examples include: regular engagement in public-facing events including festivals, lectures and panel discussions. Providing research consultancy to a range of organisations to help take knowledge from psychology and neuroscience to support performance and innovation insight; involvement with a range of presentations in major media outlets in USA, Europe, Asia, Australasia, and Africa, such as BBC, Scientific American, NewScientist, National Public Radio.

How do you define synaesthesia? Is it one phenomenon or several ones?

Synaesthesia refers to an experience where one attribute of the environment triggers a secondary experience that is not typically associated with the first. This can occur across the senses; for instance, hearing words could evoke tastes. It can also occur within them; for instance, achromatic written words might evoke colours. I view synaesthesia as an umbrella term to incorporate a range of these experiences that can either be sensory (e.g., sound to taste synaesthesia) or conceptual (e.g., knowing that the number 3 is red) in nature. In addition to the conceptual and sensory divisions, there are further subdivisions depending on the nature of the material that induce synaesthesia. For instance, there are several types of synaesthesia linked to coloured sequences (e.g., letters to colours, digits to colours), there are other types associated with spatial representations (e.g., weekdays having a specific location in space), and others not linked with sequences at all (e.g., vision evoking touch, or touch evoking vision). I use synaesthesia as a term to describe this wide variety of experiences, but I am mindful that the mechanisms contributing to each subtype may vary.

To what extent is synaesthesia inborn (genetically determined)? What are the causal influences of learning and cognition in its occurrence?

Many cases of synaesthesia are reported to be developmental in nature. That is to say that they are present from childhood. There has been evidence for some time that synaesthesia runs in families, but this does not mean that family members will have the same type of synaesthesia (i.e., people within the same family may have different synaesthetic mappings). Our knowledge of the genetics is less clear, but recent work has begun to provide some clues to this. Given the variety of types of synaesthesia, it is unlikely that there is going to be a single gene for synaesthesia. Instead, genes linked to broader changes in brain development may result in a predisposition towards synaesthesia.

While predispositions may exist, there are naturally likely to be elements of learning involved in synaesthesia. A clear example of this would be in conceptual cases of synaesthesia where the inducing material must first be learnt. While this level of learning is thought to play a role, it is quite common for researchers to suggest that "learning in and of itself cannot explain synaesthesia" (e.g. Marks & Odgaard, 2005). Other researchers have questioned this assumption (e.g., Yon & Press, 2014). In particular, it has been suggested that synaesthesia may be the result of associative learning because: 1) some synaesthetic experiences can be traced back to the sensory environment in which synaesthetes developed (e.g., links between coloured letter magnets and synaesthetic associations between letters and colours), and 2) there is evidence that patterns of synaesthetic like behaviour (e.g., performance on tasks) can be induced in non-synaesthetes following perceptual training.

In what ways is synaesthesia an advantageous, an impeding and a neutral condition?

The presence of synaesthesia has been linked with several benefits to perception and cognition. These includes differences in basic sensory perception (e.g., the perception of colour in synaesthetes that experience colour), memory for material linked to synaesthetic experiences (e.g., memory for colour in synaesthetes that experience colour), and broader skills like mental imagery and creativity. With regards to the latter, it is quite common in the popular literature for a number of famous creatives (e.g., artists, musicians) to be reported to have, and to use, synaesthetic experiences in their work. It is also known that the presence of some forms of synaesthesia may be linked with a greater tendency to work in creative professions. With that being said, systematic investigation of skills like creativity in synaesthesia is limited to a few studies, which provide a mixed picture as to whether synaesthesia results in benefits to creative performance and achievement beyond what is seen in the typical population. The likelihood is that whether synaesthesia is advantageous depends on the extent to which it is successfully

adopted as a strategy to aid performance. For instance, in some circumstances, seeing colours associated with music may be helpful, but in others it may be distracting. This interaction between task and synaesthesia is likely to become even more complex when factoring in other individual differences that can influence high level cognitive skills like creativity (including mood, age, and gender, to name a few). In this context, while synaesthesia may sometimes be advantageous, it is likely to be one part of the jigsaw when it comes to richness of human experience that can influence human performance.

Are people with synaesthesia special in any other way? Do all people have synaesthesia to some extent?

The question of whether synaesthetes are special or if all people have synaesthesia to some extent is a long-standing, but unresolved question in science. There are a variety of sources pointing to differences between synaesthetes and non-synaesthetes — e.g., in brain structure and connectivity, in perceptual profiles, and in cognition. However, given that synaesthetic-like experiences can be induced (e.g., via training or artificial interventions) in people that do not previously have synaesthesia, this may imply that we all have the capacity to be synaesthetes. Synaesthetic experience can be mapped onto cross-modal associations that we all share. For example, in the majority of people, dark colours are linked to low tones, while bright colours are linked to high tones, even if they do not report any conscious experiences of colours. This pattern is also seen in synaesthetes, except they do report percept-like / conscious experiences. It is therefore possible that a basic scaffolding exisits to permit us all to experience synaesthesia to some degree. Some would argue, however, that just because we can induce synaesthetic-like experiences in people that do not normally experience synaesthesia (e.g., via training), this does not mean that they are having the same experience as synaesthesia or that people arrive there through the same mechanism as synaesthesia.

What is your story (and impression) of reading Alexander Luria's *The Mind of a Mnemonist*?

Luria's *The Mind of a Mnemonist* is a very important book to the field, and to my own interests in synaesthesia. I came across it very early on in my career in synaesthesia research and it was important in generating several themes that I have worked on over the last decade. For instance, one major question in my research has been to investigate how synaesthesia can influence wider aspects of perception and cognition. Luria's book is a classic example of investigating the scope of synaesthesia on cognition. As a neuropsychologist, it is also a prime example of how understanding an individual can be a rich source of insight into functioning of human cognition as a whole.

Why is it important to do research into synaesthesia? What are its promises for cognitive science or science at large?

Synaesthesia provides a unique and fascinating experimental window to study the mind. The variety of types of synaesthesia offer the potential for it to speak to a wide range of areas of human perception and cognition. A clear example is consciousness. In synaesthetes, we have a powerful means to examine how subtle changes in brain development can have profoundly different effects on conscious experience.

Synaesthesia can also be used as a model to examine theories of broader aspects of cognition. One example of this relates to the study of mirror-sensory synaesthesia (where synaesthesia report experiencing first-hand sensations when viewing touch or pain to others). People are thought to experience mirror-sensory synaesthesia due unusual interactions between self-other representation (the ability to distinguish and switch focus between representations of oneself or somebody else) and vicarious perception (the ability to match observed states of others onto representations of our own first-hand experience). Interactions between self-other representation and vicarious perception are thought to be important to how we all experience empathy (the capacity to share the experiences of others). Learning how these interactions vary between us, as in mirror-sensory

synaesthesia, can therefore provide a powerful opportunity to gain unique insights into the functioning of empathy in us all.

You concluded that colour synaesthesia is linked to an increase in two factors of schizotypy (unusual experiences and cognitive disorganisation), "implying that the presence of synaesthesia is associated with widespread differences in cognition that extend beyond the synaesthetic experience itself" (Banissy et al., 2012). How widespread are these cognitive differences? Are these causes or consequences of synaesthetic experiences? Why don't these factors feed into other dimensions of schizotypy and how do they relate to other individual differences at large?

The question of whether synaesthesia is linked to broader cognitive differences has gained traction in recent years. There is now a growing list of cognitive or trait-based differences where synaesthetes have been reported to differ to non-synaesthetes. Positive schizotypy is one trait where this has been shown to be the case (we found this in both our 2012 and 2016 studies). In 2012, we also found a difference in cognitive disorganization; but we did not find this in our most recent study in 2016, so this requires further replication. The question of why would synaesthetes differ is an important one. In principle, it could be a number of factors: a) high positive schizotypy is causal to synaesthesia, b) synaesthesia is causal to high positive schizotypy, c) neither are causal to one another but are linked to some commonalities or a moderator that links the two. There is no strong evidence to disentangle these possibilities at present, but the most parsimonious explanation would link to the last explanation. High positive schizotypy is also linked to higher creativity and mental imagery — two skills which synaesthetes are also found to be higher in. It is therefore possible that there might be a constellation of traits and abilities linked to synaesthesia through some common moderator, e.g., a broader propensity towards these linked abilities due to some commonality in mechanisms of brain development.

Which type of synaesthesia fascinates and/or intrigues you the most? What is the most memorable (interesting, baffling) case of synaesthesia that you came across during your career as a synaesthesia researcher? Why was it interesting and how would this contribute to (neuro)science if we could know its mechanisms?

From a personal perspective, I've always been most fascinated by word-taste synaesthesia. From a scientific point of view, I think I'd have to go for the more controversial types of synaesthesia — ordinal linguistic personification (OLP) and mirror-sensory synaesthesia. The reasons are twofold: 1) as a social cognition researcher, I think both experiences can provide a unique window into how we understand and perceive others (broadly defined to include non-living others in OLP); and 2) the question of whether they are synaesthesia or not helps us to engage in a discussion about what we think synaesthesia is, how do we measure it, and what mechanisms drive it. Even if we were to conclude that OLP and mirror-sensory synaesthesia fall outside of standard definitions of synaesthesia, I think learning more about them helps to constrain our understanding of synaesthesia and engage in critical discussion of how the field categorizes synaesthesia.

What is your current "pet peeve" most annoying misconception about synaesthesia? What ideas about synaesthesia has your experience of researching synaesthesia made you get rid of? What do you feel is the main thing currently being overlooked or ignored in synaesthesia research?

I think my general peeve relates to assumptions that synaesthesia has to be consistent over time. While for researchers having consistent synaesthetic experiences is important to help us test for the experience, I think any assumptions that this means that people who have inconsistent synaesthetic experiences (e.g., A being red on one occasion, but A being green on another) are not synaesthetes are potentially wide of the mark. Instead, what these cases reflect are simply evidence of how our measures are potentially impoverished and need to be improved to capture all potential cases, which may fall outside

of standard measurement ability. In my view, improving measurement and improving our theoretical models for explaining synaesthesia is a key challenge to future research.

To what extent, or how far, do you expect we can push CGI-body morphing and identity alteration for those with mirror touch synaesthesia? Retrospectively, does CGI-based body and identity flexibility make us all more like MTS? Do you expect more MTS through increasing CGI-based exposure to more purposeful and flexible body morphing and identity selection?

One theory of mirror-sensory synaestheisa is that they have a greater tendency to blur the boundaries between self and other. In this regard, you might expect that people with mirror-sensory synaesthesia may be more susceptible to illusions linked to self-other merging (both in virtual reality and the 'real-world'). There is already some evidence to point to this (e.g., Cioffi et al., 2016). The question of how this altered self and other merging contributes to degree of synaesthetic experience in mirror-sensory synaestheisa is an empirical one, that as yet has not been directly investigated. For instance, does an increase in self-other merging lead to an increased synaesthetic response or is the synaesthetic response simply an all or nothing event once self-other merging has taken place. It would be interesting to explore this avenue further.

Do you feel that there is an important relationship between Autonomous Sensory Meridian Response and synaesthesia? What are the significant similarities and differences between the two? (asked by Lyubov' Belugina, a member of RSC). Can some synaesthetes develop more sensitivity to ASMR-situations?

There is some data linking Autonomous Sensory Meridian Response (ASMR) with synaesthesia (e.g. Barrat & Davis, 2015). These studies have suggested a greater self-reported prevalence of synaesthesia in people who report experiencing ASMR. In a related context, we have also found that people with ASMR have a similar personality profile to that reported for people with synaesthesia for colour

(Janik-McErlean & Banissy, 2017). With this being said, the exact link between the two experiences has not been directly studied and further work is needed before any clear inferences on links between the two experiences can be made.

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María José de Córdoba Serrano:

> It is, indeed, the discovery that I myself have always been a synaesthete that is the reason for my interest in studying and researching the topic, both in the artistic, scientific, and educational fields.

Maria José de Córdoba Serrano, Ph.D., has a Doctorate of Fine Arts from the University of Granada, Spain. A multidisciplinary artist, she is a full professor in the Department of Drawing at the Alonso Cano Faculty of Fine Arts of the University of Granada. She has been a researcher in the field of synaesthesia since 1988. She has held the position of general Director of the International Foundation Artecittà since 2005. From 2008 to 2018, she was a member of the research group Cognitive Training, at the Department of Experimental Psychology, and was in charge of the research group "Synaesthesia and Creativity: Applied Interdisciplinary Research" of the University of Granada. She has received national and international awards, and has given more than 200 exhibitions, solo and with others, since 1984. She received the 2009 Medal of Merit for the Fine Arts from the Royal Academy of Our Lady of Anguish, Granada. Her works have been recorded in national and international dictionaries, catalogues and museums.

How do you define synaesthesia?
Is it one phenomenon or several ones?

For me, it is a real perception, a natural condition, that allows me more sensory and emotional information of the perceptual world learned in my life, because I have had it since I can remember. It is a quality that allows me to perceive more than one sensation with only one sensory input in any of my five senses; and not only in my five senses, but also in sensory perceptions related to cold, heat, pain, emotions, … There are conceptual synaesthesias perceived with high intensity, very conscious, and others that are perceived less consciously. But I realize them if I pay attention. And others, those that are totally subconscious, which we would call false synaesthesias (quasi-synaesthesia or pseudo-synaesthesia), nowadays called "ideasthesias", that could be a very slight synaesthesia linked to the understanding of concepts in a learned language. However, I have other synaesthesias that are pure primary perception; that is, not linked to cognitive / perceptive development. Defining it in a simple way is currently very difficult, because we still need to investigate much more about what causes them and why.

Secondly, as a researcher, based on existing theories and my own hypotheses and theories, it could be defined as a neurological condition that we have from birth, that for some reason is lost as we grow, and that only some people continue to maintain into adulthood, consisting of a hyperconnectivity between brain areas related to the senses and areas of language, emotions, etc. We can find literature about it in *Synesthesia: Theoretical, artistic and scientific foundations* (Granada, ed. Fundación Internacional Artecittà, 2014).

To what extent is synaesthesia inborn (genetically determined)? What are the causal influences of learning and cognition in its occurrence?

Considering that we are all born with a hyper-connected synesthetic brain, according to the well-known studies of Daphne Maurer (*Synesthesia: a new approach to understanding the development of perception*, in *Proceedings of the III International Congress of Synesthesia, Science and Art*, ed. Artecittà, 2009) and others, and the fact that only a few people can maintain this

condition into adulthood, logically, you can think that it must be in the development of learning the world around us, surroundings and language ability. That is, there is a genetic predisposition, but it is also very likely that the cultural, physical and educational environment interferes with the permanence of this condition in adulthood.

In what ways is synaesthesia an advantageous, an impeding and a neutral condition?

In most of the reports received from people with synaesthesia, it is considered advantageous in many aspects. For example, it is noted that it enables creative development, or both conditions go together. Both in the results obtained in my research on the possible relationship between synaesthesia and creativity, via surveys carried out with students of Fine Arts at Granada, and also in regards to memory capacity, since it is used as a mnemonic rule; these would be two of the positive aspects that we could aim for. There are many skills related to synaesthesia and creativity, not only in the plastic arts, but also music, science, and innovation. Synaesthetes seem to have a creative and innovative, holistic way of thinking, as if this condition had facilitated the development of multiple intelligences for which human beings have potential.

Depending on the intensity of these crossed sensations, we can perhaps talk about their neutrality or their imperativeness, but we would enter again into debate about whether all the synesthetic experiences are real synaesthesias or ideasthesias. That is, if "synaesthesia" should be defined, its definition now being so highly inaccurate. What we can rightly say is that these feelings are not via thinking about things: they are felt and perceived without our control. We just have them. All those who are synaesthetes do not decide if we want to be synaesthetes or not. It is an irrational and uniform experience over time.

Are people with synaesthesia special in any other way? Do all people have synaesthesia to some extent?

I think that many of the people with synaesthesia are also hypersensitive and have a degree of empathy far above normal. For this reason, we could also say that they are a little more special than others. I have also seen this in my survey studies. Regarding the rest of the abilities

that are attributed to people with synaesthesia, and that we can read about in a multitude of articles at present — for example, that they are possessed of a greater intelligence, or are able to reproduce exact musical tones, or have a superior memory — it is still too soon so for us to conclusively state whether those are true. As I said before, there is still a long way to go in the study of synesthetic personalities and special abilities, synaesthesia's neurobiology in relation to brain structures, and encoding and decoding processes of sensory information. Although there are indications, they are just that: indications that must be corroborated with more extensive studies worldwide.

If we consider "ideasthesia" as a "slight synaesthesia", then we can say that, yes, all people have some degree of conceptual synaesthesia. However, if we consider that "true synaesthesia" is only that high-intensity synesthetic experience and related to the primary perceptions of childhood, then it is much more difficult to say that all adults have some degree of synaesthesia. Since, throughout the life of the brain, structures have been changed, in a plastic way, it may be possible that many of the interconnections of our brain no longer exist in adulthood if these have not been used, empowered or exercised.

What is your story (and impression) of reading Alexander Luria's *The Mind of a Mnemonist?*

Luria looked for the relationship between brain and behaviour. He was an interactionist, relating psychological and cognitive processes with behaviour. Considered as the precursor of Soviet neuropsychology, his work formed part of a core of fundamental reflections at the beginning of the Soviet revolution, with Alexei Leontiev and Lev Vygotsky. I like his thinking and theory about the influence of cultural and environmental forces on how brain systems develop and function. I agree.

He studied the case of a synaesthete with a prodigious memory in *The Mind of a Mnemonist*: *A little book about a vast memory* (1968) and tried to demonstrate that the development of that prodigious memory was related to synaesthetic capacity, and I think it was right.

Most synaesthetes consider their memory very good because they use their synaesthesia as a mnemonic device.

Why is it important to do research into synaesthesia? What are its promises for cognitive science or science at large?

As I explain in the summary of my article *Why study synesthesia? What can that teach us about ourselves?* (*Theoria et Historia Scientiarum*, 2013): It outlines several surveys of potential synaesthetes and possible relations of synaesthesia, creativity and types of "sensory representation"/ intelligence… "natural synaesthesia" as multi-modal thinking actualized through diffuse perception and polyphonic attention. Such an understanding emphasises the importance of constant philosophical reconsideration of synaesthesia and an interdisciplinary approach to researching the phenomenon. One of the major conclusions made in this essay is that synaesthesia is embedded in the multiple and multilevel processes of the unconscious that constitute both thinking and creativity. Which in turn might mean that perception could be explained through synesthesia and not the other way around, with subsequent revision of the theories of cognitive processes in psychology and neurosciences. Results lay the foundations on synaesthesia-based applied methodologies in art education that are aimed to raise awareness of unusual perception among potential synaesthetes and enhance holistic creative thinking of the students through the multi-sensory aspects that they can further include into their own.

Regarding pedagogical methods, how do you help students distinguish and discriminate between cross-modal correspondences and synaesthesia? What do you explain about synaesthetes' potentials? Who of the world-famous artists and composers do you consider true synaesthetes?

Let me do an introduction: During the first years (2006/7) of surveys among the students of the Faculties of Educational Sciences of the University of Granada, the protocol that I followed took into account that the main objective that motivated us was to conduct research in this population group (see more in interdisciplinary

research on synaesthesia, *Development and objectives. First phase* (Proceedings of the *II International Congress of Synesthesia, Science and Art*, 2007)) to inform about the possible existence of this condition among their future students and their impact on the educational development of the child. At the same time that we informed, with rigor, of the new advances in the knowledge of this not-so-rare condition, we dissipated confusions about the concept / term "synaesthesia" and we emphasized the need to take into account this knowledge in future didactic plastic expression and even to be able to enhance it in its positive aspects (see below). The methodology and development of the research was as follows:

1. a) Lecture Conference and discussion on "what is synaesthesia". Population group: First-year students: Children's speciality, subject "Development of plastic expression and its didactics", ages between 19–36 years.

b) Sample simple test form based on the studies of other researchers whom we contacted in the first Congress on "Synesthesia and Art", held in Cuevas del Almanzora, Almería, Spain, 2005, organized by the Artecittà International Foundation and the University of Almería, Spain, such as Julia Simner, also interested in this matter in the later years.

2. Evaluating the first results, we moved to a second, more concrete test, in collaboration with Emilio Gómez Milán, from the Department of Experimental Psychology of the University of Granada, about:

a) the more than fifty synesthetic categories found up to those years, according to the statistical studies of Sean A. Day (2006);

b) the personality and psychological peculiarities of possible synaesthetes.

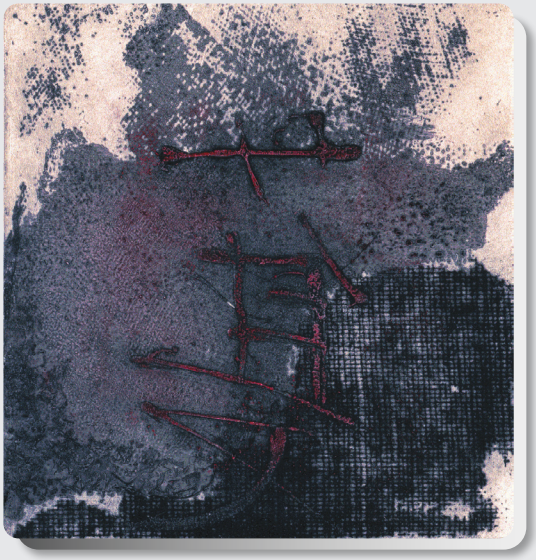
Among other information, as reflected in the article referenced above, "On the question of whether educators need to know about synaesthesia, in most cases all scholars and researchers of the moment have talked about how teachers need to be aware that synaesthesia leads to greater distraction in the child, or the interferences of their perceptions in learning, and their rarity, (example:

2 + 5 is equal to purple). However, there is another potential aspect of synaesthesia that teachers or educators may need to know, and it is the possibility that synaesthesia would be linked or very closely linked to improved memory, or 'photographic' or eidetic memory, cognitive abilities which are anecdotally attributed to synaesthetes."

In 2008, I joined the Research group called "Cognitive Training", of the Department of Experimental Psychology of the University of Granada, participating in a multitude of research projects on the peculiarities of people with synaesthesia, among which are: Mental Flexibility and Synaesthesia (2009-2013) (*Cognitive Flexibility in Synesthesia and Cognitive Rehabilitation 2009-2013*). Specifically, my role was to study the relationship between synaesthesia and creativity (*Polling of possible synthetics in the educational scope*, 2009). As a professor at the Faculty of Fine Arts, I began to apply teaching units aimed at enhancing the creativity of students by enhancing their multisensory and synesthetic abilities. For all of this, I created workshops on auditory somatosensory self-exploration; drawing, audiovisual, pictorial and two other tests on originality and systems of sensory representation were devised through drawing, in the first new test, and language, in the second new test. Of course, from the beginning, the students, after being rigorously informed about the difference between what is really synaesthesia, and its multiple types, categories and intensities, and about what are the "normal" multisensory relationships and associations, ideasthesia, know and are aware of whether or not they have authentic synaesthetic abilities. The results of the study have been published in the proceedings of the congresses organized in Almería, Granada and Alcalá la Real, Jaén, (Spain), in the years from 2009 to 2015, as well as disseminated in manuals such as "The Kiki Bouba universe: Ideasthesia, Empathy and Neuromarketing" (2014).

Regarding legendary artists whom I consider to be real synaesthetes, I look to Paul Klee much more than to others considered as synaesthetes; poets such as Federico García Lorca or Juan Ramón Jiménez; and, for composers, musicians, and painters, John Cage.

Maria José de Córdoba Serrano, *Desiero 1*, 100×88 cm, mixed media on canvas, 2017



Maria José de Córdoba Serrano, *Protecion*, dimensions: super-alpha paper 38×50 cm; crystallized polystyrene plate: 20×20 cm, intaglio engraving on synthetic polymers, 2003

Maria José de Córdoba Serrano,
Sonido del Silencio, 50×50 cm,
mixed media on table, 2018

As synaesthesia is researched further, what additional types do you anticipate we might find, or find are more prevalent than we previously thought? How do you think we might discover these, using what tools, methods, or theoretical approaches?

At least in the Spanish population, according to the data collected in my study, it is found that the most common category is sound/colour. There have also been advances related to the tactile sensations associated with textures, cold or heat, taste and also emotions: joy or sadness. Surprisingly, some very curious findings about personality concepts and forms / food, such as: chickpea people or almond people; or colours and the feeling of hunger or satiety, for example: green makes me hungry. For me, personally, the sometimes-experienced voice / tone / smell is rare.

I believe that, in addition to continuing with the current methods in the search for people with synaesthesia, we should look at test probing, as well as the multisensory self-observation workshops and activities I proposed years ago (De Córdoba Serrano & Jerónimo Zafra, 2005), with the help of an expert in electronic physics, to create a mathematical model of synesthetic processes. It would be the solution to finding and understanding valid answers about how and why these types of perceptions occur, as well as their categories and mechanisms that originate in our mental and neurological structure. But for this, as I always say, the population that we must have to conduct this method must be broad, and we are still working on collecting this database of people with synaesthesia and expanding that search in Africa, Asia, and in other South American countries (De Córdoba Serrano, 2015).

Most of your own projects regarding synaesthesia involve painting and drawing, visualizing aspects of another sensory mode, such as "painting music". However, looking at others' (or also your own) experiments and projects where the artistic creation is not visual, but, instead, of some other sensory mode (e.g., creating a perfume, or combining food flavours), whose and what synaesthetic or cross-modal work has fascinated and intrigued you the most, and why?

There are currently many interesting projects on olfactory and gustatory synaesthesia, including thermography and synaesthesia, by my colleagues Emilio Gómez and Oscar Iborra (2015). But what fascinates me and what I would most like to find out about, as an Andalusian and a person who enjoys the sound of the guitar, and the intensity of flamenco and "cante hondo" (I have also enjoyed playing the guitar since I was a child), is whether the following could be a new category. Sometimes, when listening to flamenco, the movement of my feet become autonomous. I do not control how they move; it is an unconscious movement. Apart from the rhythms having texture and colour, they also have movement, visual and corporal. That is, I would very much like to see more studies and research projects on kineto-synaesthesia.

To what extent, and how and why, did the fact that you yourself are a synaesthete influence your decision to research synaesthesia? Do you think being a synaesthete gives you an advantage in studying the phenomenon?

It is, indeed, the discovery that I myself have always been a synaesthete that is the reason for my interest in studying and researching the topic, both in the artistic, scientific, and educational fields. My education, in my youth, was in psychology and education sciences, although I am currently a professor at the Faculty of Fine Arts and an artist. This made the interest more in the search for new theories of perception and creativity, with the use it, perhaps, only for my artistic production. My interest in the study of synaesthesia has always been multidisciplinary and scientific.

Being a synaesthete, in different grades and categories, it facilitates my seeking the better direction and approach to research projects. I also know, in the first person, what it is to be a synaesthete and how this type of perception is experienced, a fact that other researchers on the subject cannot know and understand so easily because they do not have this kind of perception of reality.

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Danko Nikolić:

> I think that the insights about ideasthesia, i.e., that synesthesia is in fact a semantic phenomenon, tells us a lot about where we should be looking for the answers on how our brains create phenomenal experiences.

Danko Nikolić received a degree in Psychology (1994) and a degree in Civil Engineering (1992) from the University of Zagreb, Croatia. Nikolić received his master's degree (1997) and a Ph.D. (1999) form the Department of Psychology at the University of Oklahoma, USA. In 1999, he joined the Department of Neurophysiology at the Max-Planck Institute for Brain Research, where he headed a neurophysiology lab for over 17 years. Synesthesia was at first a side project but soon became one of the hot topics intensively studied by his research group. After obtaining insights into the nature of synesthesia, he proposed the concept of ideasthesia; i.e., the idea that we phenomenally experience activation of concepts. Ideasthesia seemed as a better way to describe synesthesia. In addition, Nikolić performed a number of studies about neuronal activity in the visual cortex using invasive recording techniques. These studies resulted in the theory of practopoiesis — a theory of hierarchical adaptations in the nervous system. Practopoiesis integrates understanding of life in general with the understanding of brain functioning. Practopoiesis has profound implications for creating advanced AI technology. Nikolić's goal is first to understand the physiological underpinnings of hierarchical adaptations in the nervous system and then to integrate this knowledge with concept sensing of ideasthesia. Nikolić is an honorary associate professor at the University of Zagreb. Currently, he is working in industry, developing AI solutions and heading a Data Science team at savedroid AG in Frankfurt, Germany.

How do you define synaesthesia? Is it one phenomenon or several ones?

I avoid definitions that imply crossed senses or an ability to perceive stimuli by a different modality. In my option, these definitions are misleading. I think that synesthesia is in its very nature a semantic phenomenon. It is a way to understand the world, not to perceive it. Therefore, I believe that the concept of ideasthesia—i.e., "sensing ideas"—describes much better what the nature of synesthesia is. Moreover, I do not think that there are different variants of synesthesia like for example, low-level synesthesia with crossed senses and high-level synesthesia based on semantics. Also, I do not think that semantics is just an additional property of an otherwise low-level phenomenon. I think all variants of synesthesia are semantic in their nature, in all cases and for all persons. In that sense, I believe that what we study under synesthesia is a single phenomenon.

To what extent is synaesthesia inborn (genetically determined)? What are the causal influences of learning and cognition in its occurrence?

There is clearly a genetic component to synesthetic capabilities. This can no longer be doubted. One is born with the capability to create synesthetic associations.

When it comes to learning, or creating, new synesthetic associations, I think the most important factor is abstractness of the learning problem. When the content is to a high degree abstract, a synesthetic person is likely to create a synesthetic association. It seems that synesthetic modalities such as, e.g., grapheme-color or tone-color are established most commonly in the childhood. The age at which these are created is most likely 3-7 years when the child learns first abstract concepts such as numbers, letters, days of week, and others.

In what ways is synaesthesia an advantageous, an impeding and a neutral condition?

I think that synesthesia offers advantages in learning abstract concepts and then memorizing information about those abstract concepts. For

synesthetes, it is easier to deal with numbers or with musical tones if they have a synesthesia for those. On the other hand, there may also be a disadvantage. Non-synesthetes must develop different strategies for learning and memorizing the same abstract concepts that synesthetes can manipulate with such an ease. The strategies of non-synesthetes may be more difficult to learn and may need be much more elaborate. The advantage for non-synesthetes may be in that their strategies may be more suitable for dealing with abstract disciplines such as math or physics. But there is nothing that stops synesthetes from developing such skills too. It may just happen so that they get a bit 'spoiled' by having an easier ride through parts of the educational system.

Are people with synaesthesia special in any other way? Do all people have synaesthesia to some extent?

Probably there is little tiny ray of synesthesia glowing within each of us. This is quite possible.

Why is it important to do research into synaesthesia? What are its promises for cognitive science or science at large?

I think research on synesthesia can help us find answers to some of the most difficult problems that cognitive science faces—the problems of phenomenal experiences, a.k.a. qualia. Basically, research on synesthesia investigates a unique form of phenomenal experiences. The more we understand their origin and the rules by which they 'behave', the more we learn about phenomenal experiences in general. The field of synesthesia may be the only one that studies phenomenal experiences with full scientific machinery and the maximum systematicity. I have a feeling that something good will come out of all that. I think that the insights about ideasthesia, i.e., that synesthesia is in fact a semantic phenomenon, tells us a lot about where we should be looking for the answers on how our brains create phenomenal experiences. What we need to do is investigate how semantics is implemented in the brain and then how these semantic processes give rise to phenomenal experiences.

You stated that you "think all variants of synesthesia are semantic in their nature, in all cases and for all persons".

How could we see drug-induced synaesthesia and/or synaesthesia resulting from injury (e.g., an epileptic episode, a bullet wound, or a tumour) operating in this system or differing from congenital synaesthesia?

When I made this statement, I had not in mind drug-induced and injury related synesthesias. If we include those other variants, then I have to take back my statement. Instead, my reply is "I don't know". I haven't preformed research on these types of synaesthesia. I do not feel sufficiently informed to make a decisive conclusion. For these two additional types of synaesthesia, i.e., drug- and injury-caused, a possibility remains that they are in fact "low level", non-semantic synesthesias. But more research is needed before we can make such a conclusion.

Interestingly, I think I have a personal experience with a low-level synaesthesia. Let me tell you a story. Long ago, before I even began researching synaesthesia, I was in my lab preparing some stimuli for animal experimentation. I think by mistake I induced a synaesthesia that seems to have all the properties of what we may now call "low level" synaesthesia. I was coding visual stimulation for one neurophysiological experiment on cat visual cortex and, as it happens, I had a bug in my code. The visual stimulus behaved in a way that I have never seen before. Instead of displaying a smooth sinusoidal change in luminance of a grating that slowly drifts over a patch of the screen, I saw a broken grating that rapidly alternated behaviour between smooth movements and abrupt jumps. The stripes of the grating would for a short while move smoothly and then they would jump to some other position, then move smoothly again, jump again, and so on.

While watching that pattern and trying to figure out where the bug was, I suddenly heard a high-pitched tone. My first thought was that one of the "ping" machines in the lab went off. I had a lot of "ping" machines — kind of like in the famous sketch by Monty Python. So, I started checking. But then the sound was gone as soon as I started searching for the source of sound. Then I was again back to the stimulus and the sound was back too. Hmmm… Maybe something

is wrong with the graphic card, I thought. Then, I did a few quick experiments by turning the stimulus on and off, turning the monitor on and off, closing and opening my eyes. At the end, it became clear: The sound was only in my head. There was no sound in the room.

Wow. Synesthesia, I thought.

At that time, I knew about synaesthesia only what was the common wisdom written in textbooks; i.e., that synaesthesia is a phenomenon of cross senses. I talked about my experiences to one wannabe synaesthesia researcher. She had no answers for me.

I left it there. I never got back to this phenomenon, never investigated it further. This is probably a pity. But one simply cannot do it all. Importantly, this "case study" carries a message for your question: there could possibly exist true "low level" synaesthesia. And there could be even cleaner and easier-to-study cases than are drug or injury induced synesthesias. We need more research.

In my opinion, research is conclusive about grapheme-color and many other synesthesias; they are semantic phenomena. They are forms of ideasthesia.

Some seemingly similar individual cases of synaesthesia, such as number-colour types, are actually more or less conceptual when being (un)able to transfer, for example, upon Roman numbers. Where and how can we identify the distinction between semantics (content) and sensory aspects (form) of (synaesthetic) experience?

I think that a quick test on whether a synaesthesia is "low" or "high" can be done by answering the question: Does a person have an insight into the origin of the experience? Can a person who undergoes a certain synaesthetic experience tell immediately and reliably whether the experience comes from the outside (it is a real external stimulus) or whether it come from the inside (it is in my head)?

If the person has an accurate insight and can tell at any moment that the experience comes from the 'inside', we are most likely dealing with high-level synaesthesia. However, if the person has no such insight

and keeps making a sourcing error like I did in the above-described lab accident, we are likely to be encountering a "low-level" synaesthesia. In my own case that I describe above, I could not determine that the high-pitched tone was generated by my head. I kept searching for its source among the lab equipment.

True "low-level" synesthetes should respond to synesthetic experiences similarly to how psychotic patients respond to voices in their heads: with source errors. This is not the case for grapheme-color synaesthesia or for any other form reported by these people who we call synaesthetes.

Many if not most semantic constructs are variable. One can, for example, change one's concepts about the grapheme 'P' when moving from Roman to Cyrillic letters, or one's concepts of 'Monday' when moving from Germany to the U.S. If all synaesthesias are semantically based, what is going on that makes them so invariable?

Yes, of course. Concepts are not fixed. They can change. We have performed one experiment to address exactly this question. We hypothesized that changes in concepts will change synesthesias. The experiment confirmed the hypothesis. It turned out easy to "re-wire" people's life-long grapheme-color associations. These associations turned out not to be as fixed as they seemed. We concluded that synesthesias were stable over lifetime only because the meanings of concepts are normally stable over lifetime. The shape of A remains to mean A.

In that experiment (Mroczko et al., 2009), we trained people to create new semantic relations for characters that they have never seen before. They would see a character for the first time in their lives and then, through a 10-minute exercise, they would create a semantic association to a familiar one. Often, it would take less than ten minutes for the first synesthetic color associations to appear in response to those new characters. We not only created new color associations, but also had full control over which colors would be associated; if a new character was given the semantic function of a letter "A", then the color

If a new grapheme is used in place of an old one, synesthesia can be quickly transferred to the new grapheme. Printed by permission from TED-Ed. *Ideasthesia: How do ideas feel?* | Danko Nikolić | For more TED-Ed, visit ed.ted.com

that it would start associating with would be the one previously associated to letter "A".

In a follow up study, we trained synesthetes to become proficient in a whole new artificial mini-language, which we called Qsonz (Jürgens & Nikolić, 2012). The result was the same. Again, new color associations appeared within minutes. Moreover, this study indicated that the similarity of synesthetic colors reflected similarity of characters: Similar characters got similar colors. This result was significant because it disproved a hypothesis that this correlation between colors and shapes can exist only if connections were pre-wired at birth. We have shown that even these kinds of associations can be learned within minutes, and are thus semantic.

If, as you said, all cases of synaesthesia are based on semantics with no distinction between low and high levels of the nature of inducers, what is the diagnostic value of coining and using the new term ideasthesia rather than keeping the traditional one?

First, I have corrected myself above and acknowledged a possibility of "low" level synaesthesia, albeit not in people who we call synesthetes. Therefore, it seems like this distinction is necessary. It makes a big difference if an association is low or high level. Using the term ideasthesia is a straightforward way to indicate that one refers to "high" level processes.

Actually, I never had an ambition to change the name of the phenomenon. I never expected that the field would suddenly drop the term synaesthesia and use instead ideasthesia. If there would be an "official" change in the term used, such a change itself would probably induce additional confusion.

That I was hoping to achieve by introducing this term is to attract attention to the fact that synaesthesia that we study is a semantic phenomenon.

At that time, practically every paper about synesthesia began by stating that synesthesia was a phenomenon of crossed senses. Low levelness of synesthesia was taken as a fact. I wanted to change that.

The level of synesthesia, "low" or "high", may be the single most important question about synesthesia we can ask. So, why was nobody asking that? Why was everyone just going with an untested assumption? My goal was to make a correction there.

Was I successful? I think I was but only to a degree. There are still many papers that begin with the same old statement that synesthesia is a phenomenon of crossed senses. These papers simply ignore all the work indicating that the state of the affairs is actually different. Nevertheless, there are other papers that challenge the classical view; more evidence is being collected again and again. Over time, I hope this question will get resolved and the field will come to a consensus. I think we are still far away from a consensus.

According to the semantic vacuum hypothesis, concrete objects such as a cube do not need any assistance by synaesthetic associations. However, abstract objects such as days of week or numbers are much easier to mentally manipulate if synaesthetic associations are attached to them. Photo: shutterstock

If all synaesthesias are actually ideasthesias, and thus semantically based, how does this work regarding synaesthetes being surprised with their first encounter with certain synaesthetic concurrents (which can be a fairly common occurrence)? For example, a first-time experience with orgasm-to-color synaesthesia, or a first-time experience with touch-to-flavour synaesthesia (as in the classic example of "orange sherbet kisses", where the girl was startled by her experience)?

I think the first encounter to synesthesia is something similar to having a great new idea, or a new solution to a problem. To solve problems, our minds often have to work intensively. An intensive mental work in minds of synesthetes can lead to new synesthetic associations. As the brains work to understand the new events that occur in their lives, the brains create new synesthetic associations as a part of the solution.

When you solve a true problem, you are surprised by the solution. New insights are not something you expected. They are new. Similarly, synesthesia helps solve a problem in a novel way. The result is a surprising synesthetic association. It is a result of mind at work (Kirschner & Nikolić, 2017).

I have proposed a semantic vacuum hypothesis for development of synesthesia. Synesthesia may be particularly helpful when people face abstract concepts and have no good existing anchors to think about them. For kids, the first abstract concepts are likely days of week, numbers and letters. And this is probably why exactly those stimuli are the most common inducers of synesthesia (Mroczko-Wąsowicz & Nikolić, 2014).

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Beat Meier:

> I consider the cognitive differences in synaesthetes a consequence of the different knowledge structure that emerges due to synaesthetic experiences, rather than due to the experience *per se*.

Beat Meier, Ph.D., is Associate Professor at the Institute of Psychology at the University of Bern, where he is a research group leader. He studied Psychology, Economics, and Computer Science at the University of Basel, Switzerland, and earned a Ph.D. in Psychology at the University of Bern, Switzerland. He was then a post-doctoral fellow at the University of British Columbia, Canada, before he moved back to Switzerland. His research is focused on understanding the interplay between automatic and controlled processes, in particular in memory, learning and in the pursuit of goal-directed behaviour. Moreover, he is interested in individual differences both on a phenomenological and on a behavioural level. In this context, one line of his work aims at understanding the cognitive basis and consequences of synaesthesia. Overall, he has written more than one hundred scientific publications on the domains of prospective and retrospective memory, implicit and explicit learning, task switching and cognitive control, and synaesthesia. Before his scientific career, he worked as a musician, music teacher, and as a copywriter in an advertising agency. It was at this time that he first came across synaesthesia, due to collaboration with a colleague, a graphic designer, who had excellent visual memory.

How do you define synaesthesia? Is it one phenomenon or several?

The term synaesthesia is used as an umbrella term to refer to a "mixing of the senses" in various contexts and thus it comes in various guises. In literature, for example, synaesthesia can refer to metaphorical language (for example, "a sharp cheese", to "see red", etc.). Synaesthesia can also refer to cross-modal correspondences such as associating small objects with high pitch and light colour, and large objects with low pitch or dark colours. It can also refer to transient altered states of consciousness in which visual and auditory hallucinations co-occur; for example, after the intake of psychedelic drugs such as LSD or mescal.

Most relevant, however, synaesthesia also refers to an individual difference property, a variation of experience that affects a small proportion of people. It involves the automatic activation of an unusual concurrent sensation in response to an inducing stimulus; for example, a colour experience in response to a letter printed in black. It emerges early in development, has a genetic basis, and manifests in various guises. I typically refer to this definition of congenital synaesthesia when I use the term synaesthesia.

It comes in different forms or types which often co-occur. Most typical are inducers such as digits, letters, words, days of the week, months, or sound, and the concurrent experience is most typically related to colour or space. However, many more combinations are possible. The particular associations (i.e., inducer-concurrent pairs such as grapheme-colour) are typically idiosyncratic at the individual level and stable across time. In fact, the consistency of the synaesthetic associations is typically used as a defining characteristic of synaesthesia.

To what extent is synaesthesia inborn (genetically determined)? What are the causal influences of learning and cognition in its occurrence?

Congenital synaesthesia is most likely genetically determined. It runs in families and there are several studies that suggest a genetic basis. Interestingly, synaesthesia is rather associated with absolute pitch

than with austism, although there have been studies that found higher prevalence of synaesthetes among people with a diagnosis of autism spectrum disorder.

Besides a genetic disposition, however, there seem to be several critical phases for synaesthesia to occur and remain. As many synaesthetic inducers are cultural artefacts such as letters or digits, it is likely that a first critical phase occurs around the age of 7 years when children learn these artefacts. There seems to be a second critical phase during adolescence, during which some teenagers seem to lose the experiences. The inducer-concurrent pairs remain stable across adulthood; however, the strength of the experience can decline in older age.

In what ways is synaesthesia an advantageous, an impeding, or a neutral condition?

Most evidence for a cognitive advantage comes from the domain of memory; in particular, for grapheme-colour synaesthesia. However, not all stimuli which trigger synaesthesia are better remembered, and some stimuli which do not trigger synaesthesia are better remembered. Although, on average, synaesthetes, in particular those with coloured graphemes, have a slight memory advantage; but the memory of synaesthetes is not as extraordinary as has been suggested by a few single case studies (such as S., who was documented by Luria).

Another domain for which synaesthesia seems to be favourable is the domain of creative professions. There is evidence that synaesthetes are more often engaged in creative activities; however, standardized tests do not show consistent advantages.

Are people with synaesthesia special in any other way? Do all people have synaesthesia to some extent?

Multiple and strong synaesthesias can affect concentration and affective reactions. However, in general, I consider synaesthesia as an interindividual variation that comes together with many other interindividual differences such humour, intelligence, etc.; and although there seems to be a synaesthetic profile for some personality traits and cognitive styles, these variations are in an ordinary range.

I don't think that all people "have" synaesthesia. If we consider synaesthesia as a genetic condition, then it does not seem likely that all people have synaesthesia in the sense of idiosyncratic, involuntary and consistent experiences. However, it is possible to induce synaesthesia-like experiences, for example with drugs such as LSD, even in people who are not congenital synaesthetes.

What is your story (and impression) of reading Alexander Luria's *The Mind of a Mnemonist*?

It is a very impressive case study. I consider Shereshevsky an extraordinary person with extreme vivid imagery. It is important to take into account that he made a living as a professional mnemonist and he strategically combined his synaesthetic experiences with mnemotechniques such as the method of loci and imagery. His veridical memory ability is very impressive but his extraordinary memory is not only due to his synaesthesia. I found it frightening that, in the end, he seemed to have lost semantics by exaggerating memory techniques for veridical verbatim recall.

Why is it important to do research into synaesthesia? What are its promises for cognitive science or science at large?

First, I personally find it important that psychologist can describe and explain human experiences in general. As a memory researcher, I am particularly interested in the amount and extent synaesthesia can help to boost memory. Last but not least, synaesthesia research may be informative regarding issues related to consciousness and plasticity more generally.

Which type of synaesthesia fascinates and/or intrigues you the most? What is the most memorable (interesting, baffling) case of synaesthesia that you came across during your career as a synaesthesia researcher? Why was it interesting and how would this contribute to (neuro)science if we could know its mechanisms?

At the moment, I have a strong interest in understanding the relationship between absolute pitch and synaesthesia; however, my research in this phenomenon has just begun (Meier & Glasser, 2019).

In retrospect, I find the phenomenon of swimming-style colour synaesthesia particularly interesting because it may serve as a model for how synaesthesia can generalize across different inducers and how expertise (or habitual exposure) interacts with the formation of synaesthetic associations (Nikolić et al., 2011). The two cases whom we have investigated were both professional athletes for a long time (i.e., including the period when they acquired the synaesthetic swimming-style colour associations), and they had extensive training and thus opportunity for "practicing" the specific associations. This may be similar in the development of other forms of synaesthesia, which also likely involve a tremendous number of exposures until the associations are stable and occur involuntarily.

What is your current "pet peeve" or the most annoying misconception about synaesthesia? What ideas about synaesthesia has your experience of researching synaesthesia made you get rid of? What do you feel is the main thing currently being overlooked or ignored in synaesthesia research?

Maybe a "pet peeve" is the claim that synaesthetes have extraordinary memory. Research clearly shows that, in general, people with grapheme-colour synaesthesia have an advantage in some tests with some types of materials, but this advantage is not "extraordinary". Research on other types of synaesthesia is still in its infancy and it does not seem to be the case that all forms of synaesthesia lead to the same memory advantages (Lunke & Meier, 2019; Meier & Rothen, 2013).

Another issue that I believe needs more attention is the cognitive representation of synaesthetic inducers and concurrents in the knowledge system. Synaesthesia is a conscious phenomenon as an inducer triggers a concurrent conscious experience. Importantly, even without the presence of the inducer, a synaesthete knows that a particular inducer triggers that experience. Therefore, the association between the inducer and the concurrent is represented in the knowledge system. This has the consequence that it is not only the world of experience of a synaesthete that is much richer, it is also the knowledge organization that is different compared to non-synaesthetes. It is very

likely that these differences in the knowledge system rather than the experiences per se cause the cognitive advantages that can be observed in cognitive domains such as memory or creativity (Meier, 2013; Lunke & Meier, 2019).

An important insight is that there are huge individual differences among synaesthetes. It seems that the cognitive profile of different forms of synaesthesia also varies substantially and thus it is important to take into account different forms to come up with more general conclusions (Lunke & Meier, 2018; 2019; Meier et al., 2013). The number of inducers that triggers synaesthetic experiences in a particular person and in a particular type of synaesthesia should be taken into account. Notably, some types of synaesthesia have only very few inducers (e.g., swimming-style colour synaesthesia) while other forms have many more (Meier et al., 2014, 2015).

How do you explain the neurological (neurophysiological) mechanisms of synaesthesia if pressed for a bootstrap answer? What scientific model of congenital synaesthesia based on hard data do you subscribe to?

There is convergent evidence that, on a neuroanatomical level, there are difference between brains of synaesthetes and those of non-synaesthetes, in particular with respect to increased connectivity. However, it is difficult to say whether these are cause or consequence of synaesthesia. We know that the plasticity of the brain is huge and that changes in connectivity can also occur even across rather short environmental stimulation periods. Thus, we need more data, in particular related to the development of synaesthesia, to inform the differences that are observed on a neural level.

The results of your study show several neurocognitive differences related to synaesthesia — in different types of memory, visual imagery and different aspects of visual perception manifesting as cognitive styles or tendencies. How do you now disentangle the causal interactions of synaesthesia-related cognitive traits with regards to individual differences in attention, sensitivity, perception, memory and

synaesthesia? Which ones have similar neuronal roots, which are the cause and which the effect of having synaesthesia?

As noted above, I consider the cognitive differences a consequence of the different knowledge structure that emerges due to synaesthetic experiences, rather than due to the experience per se. In contrast, differences on a perceptual level may be directly related to the synaesthetic perceptions. For example, one can consider synaesthetes that have colour as a concurrent as colour experts and this expertise may be directly related to differences in the perceptual system.

Can synaesthesia be learned or acquired through exposure to specifically designed experience such as training?

As synaesthesia involves a genetic component, it follows that those who do not have the genetic predisposition cannot acquire synaesthesia. However, it is possible to learn associations and thus it is also possible to mimic synesthetic phenomena. For example, synaesthetic Stroop effects are possible to mimic even after a rather short grapheme-colour-association training (Meier & Rothen, 2009). More extended trainings have revealed that non-synaesthete participants can be trained such that they report colour experiences at the end of the training. However, and this is one of the critical differences to congenital synaesthesia, these experiences disappeared again quickly after the training. Thus, training may be interesting in terms of investigating plasticity or to evaluate the specificity of certain methods, but may not be very informative with respect to understanding congenital synaesthesia.

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Elena Lupenko:

> The similarity or equivalence of stimuli of different modalities is expressed in belonging to the same category, not in the similarity of their physical characteristics.

Elena A. Lupenko graduated from the Psychology Department of Leningrad State University in 1982. From 1986 to 2009, she worked at the Institute of Psychology of the Russian Academy of Sciences, in the laboratory of sensory-perceptual processes; later, in the laboratory of cognitive processes and the laboratory of developmental psychology. She was engaged in the study of mnemonic processes at the sensory-perceptual level, the psychology of color perception, and synesthesia ("intermodal unity of sensations"). In 2008, she defended her thesis on *Psychological nature of the intermodal unity of sensations*. Since 2009, has been acting as a senior researcher at the Institute of Experimental Psychology at Moscow State University of Psychology & Education. The main areas of research are the perception of facial expression, the perception of human personality by portrait image and a photo image of the face, spatial asymmetry of the face, the perception and identification of human personality of their own and others' races. She is author of 48 scientific publications, including the monograph *Synesthesia: Problems, hypotheses, solutions* (2011) and a co-author of the collective monograph *Cognitive mechanisms of nonverbal communication* (2017).

How would you define synaesthesia? Is it a single phenomenon or several different phenomena, in your opinion?

There is the phenomenon of synesthesia as an aspect of real "co-perception" and the mechanism of synesthesia, which allows for cross-modal transitions, mutual transfer of information from one modality to another. Are they phenomenon of the same nature? If this question could have a definite answer, the fundamental and essential patterns of the brain would probably become clear. We can only speculate at this point.

To what extent, in your opinion, is synaesthesia an innate (genetically inherited) phenomenon? What role do experience, learning, and cognitive mechanisms play in the emergence of synaesthesia?

As we know, real synesthesia is a genetically inherited phenomenon. Synesthesia, as a cognitive mechanism, develops in ontogenesis, based on several natural abilities that are found at the earliest stages of ontogenesis. According to Daphne Maurer (1993), from the age of one month, infants show the capability of intersensory interaction. From birth, they have representation systems that allow combining stimuli of different modalities and cross-modal transfers from one modality to another. This is possible due to the existence of more general, basic nonspecific processes. In ontogenesis, these mechanisms develop and improve. It seems that, along with other essential processes, they are the basis of cognition.

Is synaesthesia an advantage, disadvantage, and to what extent, or is it a neutral property?

Synesthesia is neither an advantage nor a disadvantage. It is a cognitive phenomenon, a given feature. Although, the fact that synesthesia is more common in people with creative aptitudes, and synesthetes have better memory development, may let us speak about some advantages. However, most likely, synesthesia is associated with the capability of artistic creativity, and a good memory is found in non-synesthetes. There is an opinion (Ramachandran & Hubbard, 2003) that possessors of the studied phenomenon can form more brain connections in general.

Do people with synaesthesia have any other characteristics? Is synaesthesia a unique property or are all people synaesthetes in one way or another?

I believe true synesthetes must have several specific features of the personal and cognitive sphere that distinguish them from people who do not possess such a phenomenon. If we are talking about synesthesia as a cognitive mechanism, this ability is more or less inherent in all people, as it has a close relationship with the process of perception and cognition in general.

How and when did you read Alexander Romanovich Luria's *The Mind of a Mnemonist*? What were your impressions at that time?

I only read a part of the book. Data of A. R. Luria on synesthete Shereshevsky caused surprise, interest, a desire to get acquainted with the phenomenon in greater detail.

In your opinion, what is the importance of research on synaesthesia? What can discoveries in this area give cognitive sciences, including psychology, and science in general?

Studies of synesthesia and a number of relevant interesting, yet too weak for explicit actualization, manifestations of synesthesia, which get cut off because of the too narrow traditional approach to its study, can help better understand the mechanisms of the brain as a whole, the more profound regularities in the functioning of the human mind, and poorly understood phenomenon and processes, such as abstract thinking, metaphor, evolution of language, and cognition as a whole.

Your Ph.D. focuses on the study of the laws of intermodal interaction of sensations. Could you give a brief outline of your research and the conclusions that were drawn from its results? Can these conclusions be generalized to inherent synaesthesia (synaesthesia of natural development)?

The dissertation focusses the study of the psychological nature of intermodal similarity. Like "true synesthesia", this phenomenon can be based on involuntary, congenital manifestations of synesthesia that are too weak for distinct actualization. With that, there is

a subjective sense of intermodal similarity or detection of identity, without real "co-perception" or secondary sense of a different modality.

We are familiar with several domestic and foreign works, which relate to intermodal comparisons in some way and indicate that synesthetic reactions depend on semantic content, on meaning (Artemyeva, 1999; Rusina, 1982; Marks, 1975; Martino & Marks, 2001). This fact, however, does not agree fully with the traditional understanding of synesthesia. Nonetheless, a growing number of scientists agree that synesthesia is based on general sensory and multisensory mechanisms inherent in non-synesthetic perception; i.e., it is a manifestation of not only sensory activity, but, equally, of a cognitive one. Then, we can talk about synesthesia not as a particular phenomenon of real perception, but as a common mechanism for encoding information, as a function of consciousness (Marks, 1975).

Our work demonstrates that the association and comparison of objects of different modalities is based on a deep and developmentally earlier level of categorization – emotional assimilation generalization. It is shown that not the directly perceived, modal-specific (physical) characteristics of the stimulus are causally important when there is a feeling of intermodal similarity; rather, what is causally important are modal characteristics that have a non-specific origin and have an emotional basis. That is, the similarity identification or subjective equivalence of stimuli of different modalities is expressed not in the likeness of their physical characteristics, but in belonging to *the same category*. And the category includes equivalent stimuli that cause the same or similar emotional response, not just physically identical stimuli.

Thus, objects of different modality, which are perceived as similar or identical, have proximity in semantic space and have domains of semantic correspondence. The cognitive functioning identified at the semantic level and operationalized the intermodal characteristics inherent in all sensations are *intensity* and *quality*, which have an emotional basis and are associated with the emergence of a subjective sense of similarity.

As for the congenital, or also called "true" synesthesia, there is no vigour scientific evidence either for the fact that it is a phenomenon of nature

or for the opposite conclusion — that "real" synesthesia and the subjective identification of intermodal similarity are two completely different phenomena. Apparently, this is the issue for further research. By the way, the capability to identify intermodal connections and intersensory equivalence were found in infants as early as one month of age (Maurer, 1993), which indicates the innate nature of this mechanism, as in the case of "true" synesthesia.

Your study involved 130 subjects. Did any people in this sample demonstrate any unexpected outcomes?

As in any study, the data differed in individual variability, indeed. Yet there was nothing unusual that would draw special attention.

In your study of intermodal similarity, you looked at stimuli of a different nature, such as the combination of color and geometric shape. What, in your opinion, is the basis of emotional-evaluative categorization: personal experience, cultural universals, the neurobiological determinants? Will the community of sensations be different under a different environmental influence (in a different culture and under the influence of different life experiences)? How does this understanding apply to the interpretation of the connections in the sensory experience of infants?

As was already mentioned, the ability to generalize stimuli of different modalities relies on the general sensory, cognitive ability, which is also inherent in non-synesthetic perception. It is, apparently, innate, associated with modal-nonspecific processes, with a deep, emotionally-saturated, and genetically earlier level of categorization. Personal experience, culture, and features of ontogenetic development, in general, are those determinants that, of course, mediate the development of this ability, but are not decisive in its emergence and formation.

If we turn to psychosemantic studies, the works of Elena Yu. Artemyeva, Viktor F. Petrenko, and other authors (Rusina, 1982; Etkind, 1979; Yanshin, 2001), following Charles E. Osgood, did not aim to study synesthesia in its broadest sense. Like Osgood, they do not

prove the existence of this phenomenon but accept it as an axiom. Despite the diversity of the authors' terminology and formulations, the main provisions of all these researchers are reduced to the existence of a common mechanism of information coding or categorization, which is universal for people of different cultures, sex and age, allows correlating intermodal stimuli with each other, acts as a mechanism of transformation information about the object from one modality to another and underlies the *integrity of the image of the world*.

In addition to the physical (modal-specific) characteristics of stimuli, this mechanism distinguishes universal "evaluation factors" in them (Osgood, Sushi, & Tannenbaum, 1972; Yanshin, 2001), which become the elements of "language", the code of such method of categorization ("genetically primary code" by Petrenko). This is the "language" of a primary assessment of the objects (the stage of "first vision" of Artemyeva; the level of "deep semantics" of Petrenko). Most of the authors mentioned above assume that the first specific feature of this code is the fact that it consists not in objective evaluation of the stimulus, but is associated with an *emotional attitude*. That is, the perceived object is initially subjected to emotional evaluation and is embedded on its basis in the "deep" semantic space of the subject based not on physical, but some *synesthetic* characteristics, and undergoes *synesthetic* transformation (Petrenko). So, any image of any object carries these estimates implicitly.

The central feature of this categorization type is that most categories are on an unconscious level, they are not verbalized, and their psychological reality is discovered only in psychosemantic experiments, in result of a reflection, in the existence of an impressive set of metaphorical comparisons in language: "cordial speech", "gloomy mood", "pink glasses", "gray melancholy", "sharp wits", etc. This is the highest level that characterizes conceptual thinking. And, in infants, the same mechanism "works", according to Ulric Neisser, at the level of innate initial cognitive processing schemes of "communication experience" with objects ("anticipatory schemes"), which are modified, and changed in the process of cognitive development, but must be presented initially (Neisser, 1981).

Reactions of the synaesthetes with congenital synaesthesia are often unpredictable and surprising for themselves. For example, the synaesthetes with taste varieties experience colors of unfamiliar tastes. Moreover, they can have two connections at the same time: associative and synaesthetic, often conflicting with each other (Sunday can be white synaesthetically and red in association with the calendar, etc.). How could we explain it using the model of emotional-evaluative mediation of overall experience?

To attempt to explain this fact, it seems necessary to conduct several experiments. It is hard to speculate on this topic.

How would you describe the overall contribution of the Russian (Soviet) scientists to the study of synaesthesia?
What is the value of these programs for synaesthesia research?

Unfortunately, there is virtually no serious research in the field of synesthesia in our country at the moment. This is due to the complexity of the subject, and the lack of material and technical base. The study of synesthesia should be in line with the use of systematic and integrated approaches to the study of mental phenomena, with the involvement of new data of ontogenetic, psychophysiological and neuropsychological studies, and the latest achievements of cognitive science in general. The value of this approach is undeniable: only through the joint efforts of different branches of science is it possible to get closer to understanding what synesthesia is.

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Helena Melero:

> I am really convinced that exploring the neural basis of synaesthesia, and all its characteristics, would deeply change the way we understand the brain both synaesthetic and neurotypical.

Helena Melero, Ph.D. in Neuroscience, is the founder and director of Synesthesia Lab Madrid, a scientific laboratory for the study of synaesthesia in Spain. She is a neuroscientist and specialist in the optimization and application of neuroimaging techniques (MRI) as tools for evaluation and treatment in neurological and psychiatric diseases. As a postdoctoral researcher, she has worked in the Medical Image Analysis Laboratory (LAIMBIO-Universidad Rey Juan Carlos, Madrid, Spain) and as a Fulbright Visiting Scholar at the Northeastern University Biomedical Imaging Center (NUBIC, Boston, USA), developing various research projects in clinical and cognitive neuroscience. She has published her scientific work in high impact journals such as *Neuroimage*, *Experimental Brain Research*, *Human Brain Mapping*, *Journal of Neurology*, *Chemosensory Perception*, and *Integrated Computer Aided Diagnosis*, and has established international collaborations with researchers in the fields of science and art (USA, Russia, Holland, China, Korea, Japan). Her multiple synaesthesias allow her to develop artistic work in several domains, such as musical composition, dance, poetry and painting. As a university teacher, she delivers lessons for undergraduate (Psychology) and graduate (Cognitive Neuroscience and Neuropsychology) students at CES Cardenal Cisneros and Universidad Rey Juan Carlos. From 2014 to 2018, she coordinated the group *Neuropsychology and Scientific Research* at Colegio Oficial de Psicólogos de Madrid. She is also a member of the Board of the Research Group on Clinical Neuroscience of Madrid (Spanish Association of Neuropsychiatry) and the delegate in Madrid of *Fundación Internacional Artecittá*.

How do you define synaesthesia?
Is it one phenomenon or several ones?

Synaesthesia is a non-pathological variation of human perception. A perceptual experience is classified as synaesthesia when it can be described as a simple perceptual attribute (e.g., a colour) that appears automatically and involuntarily in response to a specific stimulus (inducer). Usually, the associations between the inducers and the synaesthetic experiences (concurrents) are idiosyncratic, exhibit an emotional component and are stable in time; i.e., if the stimuli that elicit them do not vary, synaesthesias do not vary (Cytowic & Eagleman, 2009).

From a neuroscientific perspective, synaesthesia is defined as a perceptual phenomenon "in which stimulation in one sensory or cognitive stream leads to associated experiences in a second, unstimulated stream" (Hubbard, 2007). From this point of view, synaesthesia is one unitary phenomenon that crystallizes in more than 80 different modalities, including those in which the inducers are pure sensory stimuli — such as an odour, a sound or a flavour — and those in which the inducers include conceptual dimensions — such as personality, temporal concepts or numbers and letters.

It is important to stress that the definitional characteristics of synaesthesia are being revisited. Some researchers have questioned the notion of consistency (Cohen Kadosh & Terhune, 2012; Eagleman, 2012; Simner, 2012a, 2012b), given that longitudinal studies suggest that synaesthetic colours can change over time (e.g., losing chroma: Simner et al., 2017) and because consistency measures have limited power to explore synaesthesias produced by less stable inducers, such as voices (Melero, 2013). Also, Nikolić (2009) coined the term Ideaesthesia, to define those experiences in which the inducers are conceptual realities. From his perspective, every synaesthesia arises due to the conceptual component of inducers, even when they are sensory attributes (Mroczko-Wasowicz and Nikolić, 2014). In any case, given that the majority of research has been conducted only taking into account a few modalities — usually grapheme-colour or sound-colour — the definition of the phenomenon may change over the years.

To what extent is synaesthesia inborn (genetically determined)? What are the causal influences of learning and cognition in its occurrence?

Synaesthesia is a hereditary trait. Francis Galton, who observed and documented several cases of synaesthesia in the same family, proposed this idea back in 1883. After one century, Cytowic (1989) performed a study with 8 families and concluded that synaesthesia was inherited as a dominant trait. Later, when synaesthesia became more famous and more participants for research started to be available, several studies confirmed that the prevalence of synaesthesia among the relatives of synesthetes was higher than in the general population (Rich et al., 2005; Ward & Simner, 2005; Barnett et al., 2008; Niccolai et al., 2012). But what exactly do synaesthetes inherit? These studies had provided evidence that several modalities of synaesthesia appeared in the same family, so it seemed that there was a common genetic basis for the different types. In this context, Bargary & Mitchell (2008) proposed that the genetic basis of synaesthesia might be linked to the genes responsible for the development of brain connectivity (anatomical and functional connections). This inherited general tendency for hyperconnectivity would crystallize in different phenotypes (i.e., modalities of synaesthesia). Other authors have proposed that the genes related to the immune system, which participate in immunity but also in brain development, may play an important role (Carmichael & Simner, 2013). This theory would be useful in order to comprehend the neural mechanisms underlying congenital synaesthesias but also those acquired after brain injury.

Research about the genetics of synaesthesia is still in its infancy. Only sound-colour (Asher et al., 2009; Tilot et al., 2018) and spatial-sequence synaesthesias (Tomson et al., 2011) have been considered in genetic studies and, though this work seems to corroborate the idea that synaesthetic genes affect brain development (e.g., axonogenesis: Tilot et al., 2018), it is too soon to determine if the genetic basis is common to the different modalities. Additionally, the influence of the environment over the development of specific types and associations remains unknown.

Interestingly, some authors have tried to understand if specific-colour associations arise from learning experiences. For example, can letter-colour associations be learned from constant exposure to coloured letters? Witthoft & Winawer (2006) have reported the case of 11 congenital synaesthetes whose colour for letters have their origin in childhood toys (e.g., refrigerator magnets). So, if synaesthetic associations are learned from the environment, can we train them? Colizoli et al. (2012) investigated this question using a book with coloured letters to train a group of non-synaesthetes. Though their participants developed associations that were strong enough to produce a quantitative synaesthetic Stroop effect, the complex phenomenology that usually accompanies synaesthesia was absent (Ward, 2013). Yon & Press (2014) pointed out three arguments in favour of the learning theories; however, empirical evidence was strong enough to challenge their approach (Marks & Odgaard, 2005; Deroy & Spence, 2013b; Rich et al., 2005; Gray et al., 2006; Simner & Bain, 2013; Meier et al., 2014). Other researchers have proposed that there might be a universal tendency for the association between specific colours and letters or days of the week (Rouw et al., 2014). Additionally, a recent multilingual study (including experiments with English, Dutch, Spanish, Korean and Japanese participants) has proved that only the ordinal factor (i.e., 'A' is the first letter of the roman alphabet) can explain why the synesthete's letter 'A' is more often red in different languages (Root et al., 2018). Further research will help us understand how these learned and/or universal tendencies interact with the genetic basis of synaesthesia.

In what ways is synaesthesia an advantageous, an impeding and a neutral condition?

Neuroscientific research has corroborated that synaesthetes present increased colour sensitivity (Brang et al., 2012; Banissy et al., 2009; McCarthy & Caplovitz, 2014), better memory (Smilek et al., 2002; Yaro & Ward, 2007; Pritchard et al., 2013) and enhanced creativity (Sitton & Pierce, 2004; Domino, 1989). Other authors have reported a tendency for "greater absorption, openness to experience, and

convergent thinking", together with "a greater usage of mental imagery, verbal comprehension, and greater originality of verbal divergent thinking" (Chun & Hupé, 2016).

In my personal experience, synaesthesia is advantageous for learning, as it allows the translation of abstract concepts into tangible realities, and thus facilitates their understanding. Colour associations behave like salient cues that help me remember things easier, and spatial maps maintain abstract ideas and their relationships automatically organize. Colours, forms and spatial locations for music provide me with the ability to detect subtle changes in tuning, dynamics, rhythm and structure, which helps me to easily detect and correct mistakes when singing, dancing, playing piano and guitar. Colours for pain allow me to differentiate subtle changes that are usually unnoticed by neurotypicals, which promotes cognitive re-elaboration and eases relief (Melero, 2018). Additionally, my colours for voices and people make my personal interactions richer. In general, synaesthesia is a source of pleasure and creativity.

Some synesthetes report negative side effects, such as being overwhelmed by sensory overload. This can happen in situations that are themselves overwhelming: for example, a crowded room full of loud voices can be annoying for everyone, but an added sensation reinforces the feeling of "too much stimulation", so the situation can become unbearable. Others report feeling misunderstood and rejected by other children and/or teachers at school or in other social contexts.

In general, the most common types of synaesthesia are not disadvantageous per se, but can generate problems in situations where there is already a sensory overload, and in our interaction with people that do not know or understand what synaesthesia is. It is impeding in so far as it can sound weird and thus promote isolation from our social group. The phenomenon can also be a problem if congenital synaesthesia is mistaken for a symptom of a neurological disease, something that unfortunately still occurs. That's why it is essential to guarantee an adequate dissemination of synaesthesia research and knowledge, both in educational and clinical contexts. Synaesthesia is more often a gift, not only for

synaesthetes, but also for everyone who can take advantage of the idea of going beyond the borders of the sensory systems. In this sense, the implementation of synaesthetic devices for sensory substitution and of synaesthetic learning systems in music and painting education has proved the positive impact of synaesthesia in society. I will discuss the relevance of synaesthesia for the advancement of cognitive neuroscience below.

Are people with synaesthesia special in any other way? Do all people have synaesthesia to some extent?

Synaesthesia can be understood as a continuum that begins with universal cross modal interactions (e.g., kiki-bouba effect), and ends with rare types of synaesthesia (e.g., mirror-touch) or even acquired synaesthesias (after lesion or drug-induced). This idea has led some authors to believe that we are all synaesthetes when we are born (Maurer & Mondloch, 2005), but there is no agreement regarding this matter (Deroy & Spence, 2013).

Empirical evidence suggests that the brains of synaesthetes are quantitatively and qualitatively different. Several studies have shown structural (Rouw & Scholte, 2007, 2010; Weiss & Fink, 2009; Jäncke et al., 2009; Rouw et al., 2011; Hänggi et al., 2011; Hupé et al., 2011; Melero et al., 2013) and functional (Hubbard et al., 2005; van Leuween et al., 2010; Hupé et al., 2011; Melero et al., 2014, 2017) variations in the synaesthetic brain. Nonetheless, recent research suggests that these results should be taken with caution (Hupé & Dojat, 2015; Dojat et al., 2018).

After years of developing neuroscientific research on synaesthesia, and with the advantage (and bias) of my own synaesthetic experiences, I believe that synaesthesia arises due to the inherent affective tonality of human perception. Some years ago, I proposed the Emotional Binding Theory (EBT) of synaesthesia (Melero et al., 2013, 2014), based on nineteenth century models. At that time, Flournoy (1893) and Calkins (1895) suggested that the interrelation between the inducer and the concurrent took place due to their intrinsic emotional compatibility. The EBT is a neurobiological and integrative model that considers not only neuroanatomical and functional determinants but also takes into account the role of learning and thus the

interaction between the brain, the body and the environment. The model states that anatomical differences in emotional areas (such as the insula, or the cingulate cortex) lead to functional differences in several processing systems (perceptual, emotional and cognitive). From this perspective, I believe that different modalities of synaesthesia share common underlying neural mechanisms and that synaesthetes are special, in that their emotional processing is more efficient. As this model — and other neurocognitive models — were formulated on the basis of grapheme-colour synaesthesia, research in other modalities is needed in order to test their predictions. I have already begun to explore other modalities such as dance-colour synaesthesia (Melero, 2015), odour-colour synaesthesia (Melero et al., 2016, 2017) and pain/orgasm-colour synesthesias (Melero, 2018) and hope to find international collaboration to go deeper into these questions.

What is your story (and impression) of reading Alexander Luria's *The Mind of a Mnemonist*?

I read this book in the last year of my Bachelor's degree in Psychology. Due to my passion for neuroscience and neuropsychology, I was really interested in Luria's works and this book was an essential reading. Some descriptions of Shereshevsky resonated with my own experience of synaesthesia, especially the idea of using colours and forms to change, reduce or eliminate specific types of pain. It was really interesting to read how experiments were performed in those years and how neurophenomenological information was at the core of the medical exploration. Nowadays, we have much more technical resources, and more access to wide samples, which is an advantage in order to go beyond individual biases and build knowledge. Nonetheless, this encompasses the danger of losing subtle details and of diminishing our ability to provide individualized solutions. In the case of Shereshevsky, an apparent gift (i.e., great memory) was a problem under certain circumstances (i.e., being unable to forget irrelevant information purposely). Luria's challenge was to provide him with a real solution, an individualized one, and in his approach to this amazing case, he found a perfect balance between the scientific, clinical and

human aspects of neuropsychology. In this sense, both Shereshevsky and Luria are two exemplary characters in the history of cognitive neuroscience that have had great impact on my own research career.

Why is it important to do research into synaesthesia? What are its promises for cognitive science or science at large?

The process and the outcomes of synaesthesia research have several implications for cognitive neuroscience in general that are useful; for example, in the identification of biomarkers based on MRI in neurological diseases.

First, it emphasizes the relevance of the neurophenomenological approach, especially in neurological conditions and non-pathological phenomena with high interindividual variability (Sidoroff-Dorso, 2009; Melero, 2013). Though this approach has been present in the history of psychological evaluation and treatment, it is important to develop updated tools that account for qualitative information about the subject experiences, not only in functional disorders but also in organic diseases. These tools will help quantify subjects' reports and improve early detection of neurological disorders, even before symptoms appear.

Second, synaesthesia research constitutes a challenge for cognitive neuroscience, as it forces us to reanalysis in depth the relationship between anatomy and function: Am I a synaesthete because I was born with a different brain anatomy? Or has my functional synaesthesia rewired my brain? In this sense, synaesthesia provides a unique opportunity to investigate neuroplasticity. A joint effort to integrate functional and anatomical information to characterize the distributed networks of the brain — moving away from localizationism — will also improve early detection, assessment and treatment of pathologies in which the relationship between anatomical and functional decline is not clear (e.g., clinically isolated syndrome, radiologically isolated syndrome, essential tremor…). Additionally, the investigation of cross modal interactions, both universal and synaesthetic, will provide clinicians with new interesting tools in the field of rehabilitation.

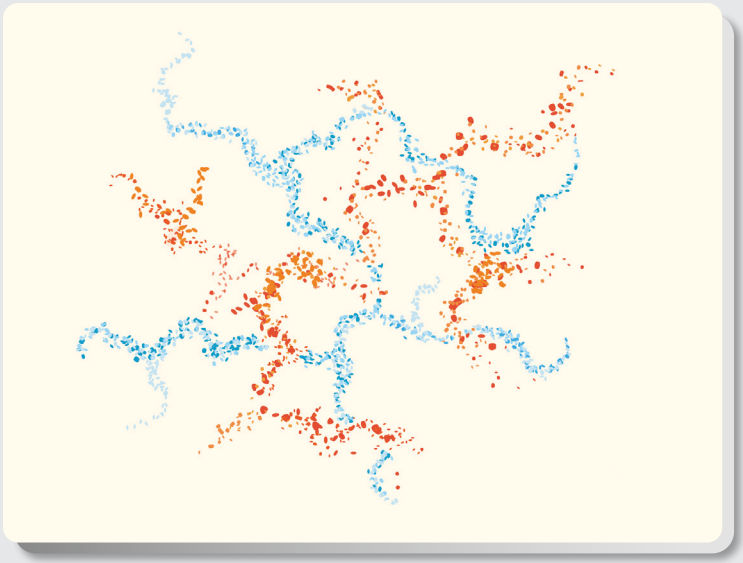
Given that the studies on the prevalence of synaesthesia have shown that it is not as rare as previously thought (i.e., even more

prevalent than left-handedness: Melero et al., 2015), this factor should be taken into account in research (e.g., participants selection), educational and clinical contexts. Finally, synaesthesia allows for a renewed approach to relevant topics in cognitive neuroscience, such as the problem of qualia, the development and acquisition of language, and the intrinsic relationship between emotion and cognition.

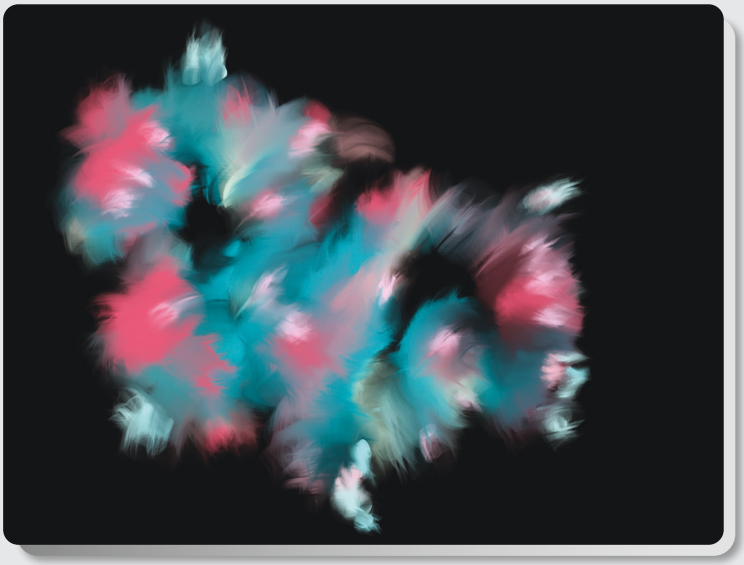
To what extent, and how and why, did the fact that you yourself are a synaesthete influence your decision to research synaesthesia? Do you think being a synaesthete gives you an advantage in studying the phenomenon?

The fact that I am a synaesthete fully determined my decision to research synaesthesia. When I realized that it was something other people could not experience, I was so surprised that I could not stop reflecting on it. I was in the last year of my Bachelor's (Psychology) and had already decided to pursue a scientific career in Neuroscience. So, all the pieces of the puzzle fit: I would dedicate my Ph.D. research to synaesthesia. Despite the challenge posed by this topic for a beginner in science, I chose to follow this path because I knew it was worthy to dedicate my time and effort to understand the neurophysiological bases of this intriguing phenomenon. I am really convinced that exploring the neural basis of synaesthesia, and all its characteristics, would deeply change the way we understand the brain both synaesthetic and neurotypical. Indeed, it is already happening and the implications and applications of this knowledge in a wide variety of fields (perception, emotion, empathy, philosophy, art, education, engineering, …) are infinite. That is why I will never quit researching synaesthesia.

Being a synaesthete is a great advantage in my profession: first, it is an advantage in general, as it provides traits (good memory, great creativity, above mean mental imagery, greater originality of verbal divergent thinking: Smilek et al., 2002; Yaro & Ward, 2007; Pritchard et al., 2013; Sitton & Pierce, 2004; Domino, 2009; Chun & Hupé, 2016) that are essential for a scientist; second, as a multiple synaesthete, I have a direct contact with the phenomenon that allows me to analyse several questions (differences between achromatic and chromatic synaesthesias,



Helena Melero, *Musical Pathways*, 173.40×130.05 mm, Art Canvas: Draw & Paint App by Samsung Electronics Co., Ltd., 2018. The picture demonstrates music perception by the author



Helena Melero, *Voices*, 108.37×81.28 mm, Art Canvas: Draw & Paint App by Samsung Electronics Co., Ltd., 2018. The image depicts the author's voice sound-colour synaesthesia

subtle changes in consistency, differences between inducers in different modalities, the feeling of seeing a colour in the mind's eye, the possibility of projecting a synaesthesia only once, …) and to test on myself several hypothesis at any time in any place. That, of course, may be also a bias, as my own experience may blur the "global picture" under certain circumstances; but that's a common problem for every researcher in the field of neuroscience: generally, we study processes we all experience (visual perception, attention, motor imagery, …) and the challenge is to go beyond our own idiosyncratic perspective to build a comprehensive model that really can apprehend the complexity of the brain. So, I believe I am really lucky to be a multiple synaesthete neuroscientist in the field of synaesthesia research.

Your research into synaesthesia draws heavily on such epistemic domains and topics as embodiment, emotion, smell, pain and orgasm. Why have you chosen this perspective? In what ways can it be more informative and what specific insights can it yield?

Grapheme-colour synaesthesia has been the preferred modality to explore several questions such as congruency, bidirectionality, the sensory/conceptual debate, etc., because a) it is one of the most prevalent modalities (Melero et al., 2015; Simner et al., 2006) and b) because, in this particular case, the inducer and the concurrent belong to the visual system, which is the most studied human sensory system and also the one that allows the easiest control of variables in experimental contexts. I myself began researching g-c for these same reasons. Nonetheless, we know that g-c is a very specific synaesthesia, different from all the others (usually intermodal synaesthesias), because the conceptual dimension that is observed in letters and numbers is not so clearly present in other inducers such as odours, orgasms, flavour, movement, noises and a long etc. (but see Mroczko-Wasowicz & Nikolić, 2014). Indeed, there are very few (if any, besides grapheme-colour) intramodal synaesthesias. That means that, if we only study this modality, our conclusions will possibly not be extrapolated to others. Additionally, the model I formulated back

in 2013 (the Emotional Binding Theory or EBT: Melero et al., 2013, 2014) understands synaesthesia as a unitary phenomenon, so it must be tested in other modalities.

Another reason to begin exploring other modalities is that, from my point of view, research on g-c may be misleading. For example, due to the characteristics of the sensory system involved (i.e., visual system), its study has unconsciously led the scientific community to a localizationist and sequential interpretation of brain activation that is incomplete. In the field of Magnetic Resonance Imaging, we are moving from localizing specific areas involved in specific tasks to exploring the characteristics of the networks that are involved and/or altered in different conditions. This methodological approach (e.g., resting-state fMRI and graph theory: Melero et al., 2017) implies another interpretation of fMRI results: instead of trying to find unusual activity in specific areas of the brain (e.g., V4: colour area), we look for unusual properties of the network as a whole. In that sense, exploring more complex inducers such as dance or pain (unstable, difficult to describe, hard to control in experiments, …) requires another methodological approach and thus forces us to rethink the way we explore brain function and anatomy.

Some years ago, I chose to start researching odour-colour synaesthesia because it is the most prevalent olfactory synaesthesia (6.13% of 1143 individual synaesthetes experience this modality: Day, 2018), and because, given the anatomical connections of the olfactory system, it is an ideal candidate to test the predictions of several neurocognitive explanatory models, such as the Conceptual Mediation Model (Chiou & Rich, 2014), the Cascaded Cross-Tuning model (Hubbard et al., 2011) and the Emotional Binding Theory (Melero et al., 2013, 2014). The results of this research in odour-colour synaesthesia (Melero et al., 2016) suggested that the Conceptual Mediation Model and the Emotional Binding Theory might be complementary and reinforced the idea that meaning and emotion are intrinsically related processes. A posterior study (Melero et al., 2017) revealed that the resting-state functional brain networks of olfactory synaesthetes are characterized

by a small-world organization (i.e., high clustering coefficient, low path length) and that the left IPS constitutes an important hub, probably by unusually integrating information from different sensory systems.

The exploration of dance-color synaesthesia (Melero, 2015) arose from my own experience with dance. My synaesthesias in response to Tango led me to analyse the nature of musical inducers, the mechanisms behind the acquisition of complex motor skills, procedural and vicarious learning, and the neurofunctional differences between voluntary and induced movement. This neurophenomenological exercise is essential in neuroscientific research and confronts us with the problem of reductionism in the investigation of synaesthesia. Finally, in 2018, I have begun exploring pain-colour and orgasm-colour synaesthesias (Melero, 2018), as a way to implement new rehabilitation strategies in the context of neuropathic pain. Interestingly, understanding the neural basis of these complex synaesthesias is helping us to make a qualitative leap in the exploration of the human brain, because at last the traditional border between emotion and cognition has begun to disappear not only theoretically but also in real practice. There is a long road ahead yet, but I believe we are heading in the right direction.

Have you had experiences with synaesthete "wannabes"? If so, what have been your reactions to wannabes? Is there any particular case, which stands out for you?

When I speak about synaesthesia (in educational, cultural or personal contexts), there are two kinds of reactions: 1) most people say they would like to be synaesthetes; 2) other people think synaesthesia means being weird and different, and they reject the topic. Some students ask me how they can become synaesthetes, and I explain that, although they may be able to exhibit the synaesthetic Stroop effect after specific training (Colizoli et al., 2012), the complete phenomenology associated with synaesthesia is still not perfectly understood and thus, for now, it is impossible to be learnt. However, I recommend them to use the concept of synaesthesia to explore their sensory sensations in depth; for example, by drawing what time looks like, painting the

forms of music or choosing the colour that best defines themselves. I also suggest they use synaesthesia as a reminder that we are all different and that diversity is not a problem but an evolutionary advantage.

Regarding some cases that stand out for me, there are two: 1) once I met a guy that, after listening to my description of synaesthesia, decided to pretend he was a synaesthete in order to flirt, because he found it very appealing. 2) back in 2009, a well-known neuroscientist told me "I envy you". At that moment, I was just beginning my scientific career, so I felt so happy that the words of this experienced researcher were implying that my synesthetic experiences might be an asset and help me in my personal and professional development.

For you as a synaesthete disciplined by science, to what extent — qualitatively and quantitatively — are your free associations, metaphoric thinking and experience-based imagery different from (or similar to) your synaesthetic couplings?

I have a strong background in Psychology and Neuroscience and I have spent more than ten years so far reflecting on synaesthesia and researching it. That means I have paid much more attention to my own perception and the level of consciousness I have about my own experience is unusually high; also, I have had the opportunity to speak with and learn from a great number of international synaesthetes and researches in the field. Additionally, I have delivered more than 40 talks about synaesthesia (in scientific, educational and cultural activities), so I have put a lot of time and effort into wondering how to a) explain the neuroscientific basis of the phenomenon properly and b), as people in the audience are always curious, be able to convey how it feels to be a synaesthete. In that sense, I am different from other synaesthetes, because they do not usually share their experiences so often and in so much detail, and because they do not have so much access to other synaesthetes, artists, philosophers, scientists, etc. Nonetheless, my associations are still absolutely automatic and involuntary, as it happens for any other synaesthete in everyday life, and I feel them as natural as they always have been.

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Anina Rich:

> I think synaesthesia can tell us about the crucial integration of what we know and incoming sensory information that together result in our conscious perception.

Anina N. Rich, Ph.D., is a Professor at the Department of Cognitive Science of Macquarie University, Sydney, Australia. As the Director of the Perception in Action Research Centre, including the Synaesthesia Research @ MQ group, Rich's research focuses on how we integrate information across the senses, including this mechanism in synaesthesia, and the fundamental role selective attention plays in our perception. Rich completed her Ph.D. in 2005. It was awarded an Excellent Ph.D. Thesis in Psychology Award by the Australian Psychological Society and was followed by a postdoctoral fellowship at the Visual Attention Lab at Harvard Medical School/Brigham & Women's Hospital in Boston, MA, USA. She returned to Australia in 2007 to take up a continuing position at Macquarie University. Rich is fascinated by the way the brain produces the richness of human experience. She is passionate about high-quality rigorous research, mentoring and research training, science communication, and improving equity in access to the opportunities provided by research. She uses behavioural, neuroimaging, and neuronal stimulation techniques to answer questions about how we select what is currently important and integrate incoming information with pre-existing knowledge about the world. She has authored multiple scientific articles on congenital synaesthesia in seminal journals and contributed chapters on some essential aspects of the phenomenon to the most influential books in the field of synaesthesia research.

How do you define synaesthesia? Is it one phenomenon or several ones?

I define synaesthesia as a phenomenon in which an ordinary stimulus evokes an extra-ordinary response — where a specific stimulus evokes a concurrent (and usually highly consistent) additional experience in either the same modality or a different modality. This is an 'umbrella' term that then covers many potentially separate forms of synaesthesia. We do not yet have enough evidence to determine the degree to which the different forms of synaesthesia share mechanisms, but those that tend to co-occur seem more likely to be linked to the same underlying phenomenon.

To what extent is synaesthesia inborn (genetically determined)? What are the causal influences of learning and cognition in its occurrence?

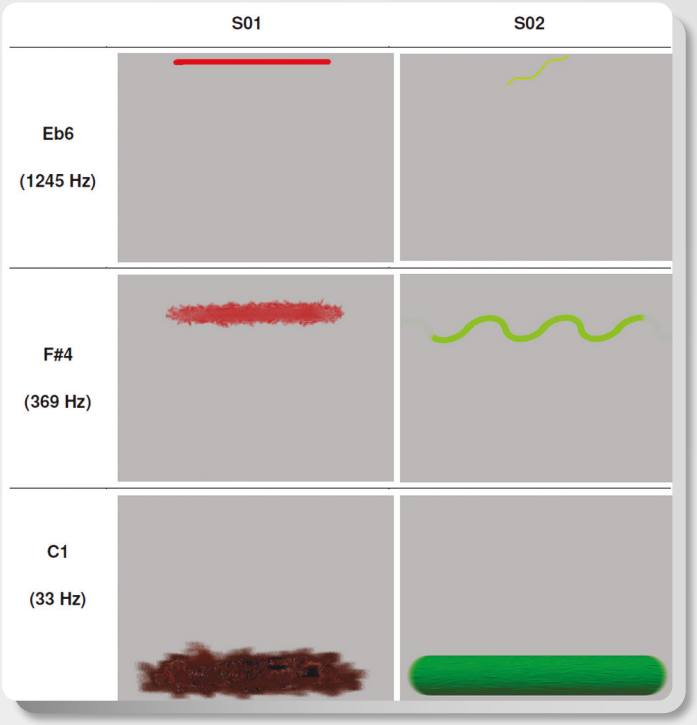
There seems to be some genetic link — for about 1/3 of synaesthetes, there is a biological relative who also has synaesthesia (although, for others, there's no clear familial history; Rich, Bradshaw, & Mattingley, 2005). This might mean that synaesthesia occurs when there is a genetic predisposition paired with particular learning environments, but we don't have enough evidence to say yet.

There must be a learning component to synaesthesia: we are not born with genetic blueprints for which language we will speak, let alone which letter might be paired with which colour, or which sound with which visual image. My hunch is that grapheme-colour synaesthesia builds on our innate capacity to make strong associations between sounds, symbols and concepts. This is how we all learn language, by making associations between sounds (and later written symbols) and important objects (and people) in our world. Although, at an individual level, the letter-colour pairings reported by grapheme-colour synaesthetes seems idiosyncratic, when we look across a large group, there are some underlying commonalities. For example, we found that, across 150 grapheme-colour synaesthetes, 13 letters of the alphabet evoked colours in certain categories (e.g., A & red) more often than predicted by chance. We also observed 11 of these

letters were more consistently associated with those particular colour categories by non-synaesthetic controls making voluntary associations (Rich, Bradshaw, & Mattingley 2005). Commonalities across synaesthetes and between synaesthetes and non-synaesthetes are consistent with there being a common learning experience at some point.

Another piece of evidence from our questionnaire data points to synaesthesia being able to generalise from one stimulus set to another (Rich, Bradshaw, & Mattingley 2005). In our data, we found that sequences that were usually rote learned at an early age, such as the alphabet, numbers 1 to 10, and the days of the week, usually had specific colours. The colour of other words, typically learned later, tended to be driven by the colour of the first letter. This suggests that, perhaps initially, grapheme- colour synaesthesia is driven by sounds, particularly those rote learned early in childhood, which then become attached to the symbols as we learn to write. We speculated that, because days of the week are learned by rote early but not written until much later, they seem to 'keep' their own colours, whereas other words seem to be driven by their letter colours, particularly the first letter of the word. Other evidence comes from synaesthetes who learned a second language — there are patterns suggesting the colours attached to the second language script are based on the colours of the initial language alphabet. This suggests foundational synaesthetic links might have a critical period and then all other experiences generalize from these initial links.

In crossmodal forms of synaesthesia, there are also similarities across synaesthetes, and between synaesthetes and non-synaesthetes. For example, in auditory visual synae'sthesia, the pattern of responses with increasing pitch is that lower tones evoke darker coloured larger objects compared with higher tones (Chiou, Stelter, & Rich, 2013). This is exactly what non-synaesthetes do in mapping pitch to colour, brightness or size (Marks, 1974). These general (usually implicit) mappings between our senses are probably based on statistical learning about our environment, and my hypothesis is that synaesthesia builds on these common mechanisms.



This figure shows responses from two audio-visual synaesthetes illustrating their synaesthetic experiences to tones varying in pitch from low (33Hz) to high (1245Hz). The underlying pattern of low notes evoking bigger, darker and lower in space experiences relative to high notes similar to what non-synaesthetes do when asked to match tones with visual stimuli. Reproduced under CC BY 4.0 from Chiou et al., 2013

In what ways is synaesthesia an advantageous, an impeding and a neutral condition?

In most cases, synaesthesia seems to be neutral, neither advantageous nor interfering. There are some cases where it seems to interfere and this varies from minor inconvenience (confusing names that share

the same colour, having difficulty remembering left and right due to colour confusion) through to a major impact (developing obsessions about needing colours to be right; facing educational challenges or disruption due to synaesthesia interfering in the classroom). For those in artistic professions in particular, it seems to be of benefit as a source of inspiration or in providing structure (e.g., for improvisation in music). Some synaesthetes report being able to use their synaesthesia in their work for things such as efficient filing (using colour-coded folders) and so on, but I do not think there is robust evidence — at least, not yet — that there are fundamental and widespread advantages to having synaesthesia in major cognitive capacities such as memory or learning. Despite this, many synaesthetes report having 'better memories' and being able to use their synaesthesia beneficially, so perhaps the objective evidence is still to come.

Are people with synaesthesia special in any other way? Do all people have synaesthesia to some extent?

Again, I think the evidence isn't there yet to say either way. Most synaesthetes seem to be just the same as non-synaesthetes except for their conscious experiences of particular stimuli. I lean toward a dimensional way of thinking about synaesthesia. My hypothesis is that synaesthetes are one end of a continuum which, at the other end, has aphantasia, a condition in which there is no ability to 'see' things in one's mind eye at all (a lack of imagery), and the rest of us non-synaesthetes are somewhere in between. This does not mean that we are all synaesthetes to some degree though — there is clearly a difference between having implicit links between (for example) pitch and lightness and actually seeing and additional experience, but the variability among synaesthetes in terms of the extent of stimuli that evoke synaesthesia (from just a few items such as days of the week through to everything in multiple senses) is consistent with a continuum framework.

What is your story (and impression) of reading Alexander Luria's *The Mind of a Mnemonist*?

I really enjoyed reading this important book. I read it during my Ph.D., which was on synaesthesia and the role of selective attention. I still

use the quotes in my lectures on synaesthesia to give a sense of the depth and richness that synaesthesia can bring to perception!

Why is it important to do research into synaesthesia? What are its promises for cognitive science or science at large?

My major motivation in studying synaesthesia is that it provides a unique window into perception. In particular, grapheme-colour synaesthesia seems to be a phenomenon where the concept of a stimulus (e.g., a letter) holds colour information much like our concept of a banana would have 'yellow' as a strong component (Chiou & Rich, 2014). Understanding this type of object knowledge — how we represent perceptual features within a concept — is still very much a matter of active research, and synaesthesia provides a novel approach to exploring these questions. More broadly, I think synaesthesia can tell us about the crucial integration of what we know and incoming sensory information that together result in our conscious perception.

In addition, synaesthesia provides a really important reminder about the inherent subjectivity of perception. We can never verify that what we experience is the same as others, and synaesthesia is a wonderful example of this. I think it's also important to remember that what we all perceive, synaesthete or not, is not what's out there in the world – it's what's out there interpreted through the lens of our knowledge, experience, and goals.

Which type of synaesthesia fascinates and/or intrigues you the most? What is the most memorable (interesting, baffling) case of synaesthesia that you came across during your career as a synaesthesia researcher? Why was it interesting and how would this contribute to (neuro)science if we could know its mechanisms?

Grapheme-colour synaesthesia fascinates me as a clear illustration of the human predisposition to make associations between concepts. We are constantly developing links between different types of information (e.g., learning the name of a new person, learning new objects and their uses, gathering data from our environment on what goes together). This form of synaesthesia seems to me to provide a unique window into the way this process might work.

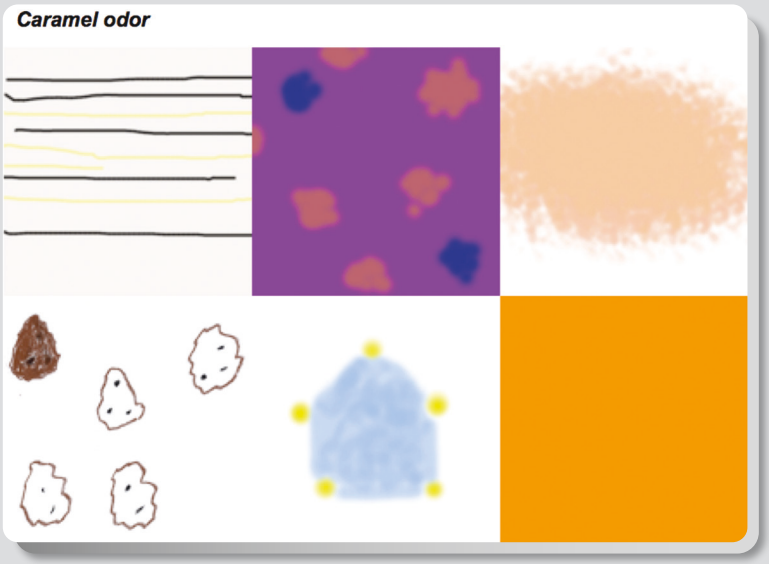
Cross-modal forms of synaesthesia, such as those in which sounds or smells evoke colours, are also really intriguing. They illustrate our tendency to try to make sense of our multisensory environment.

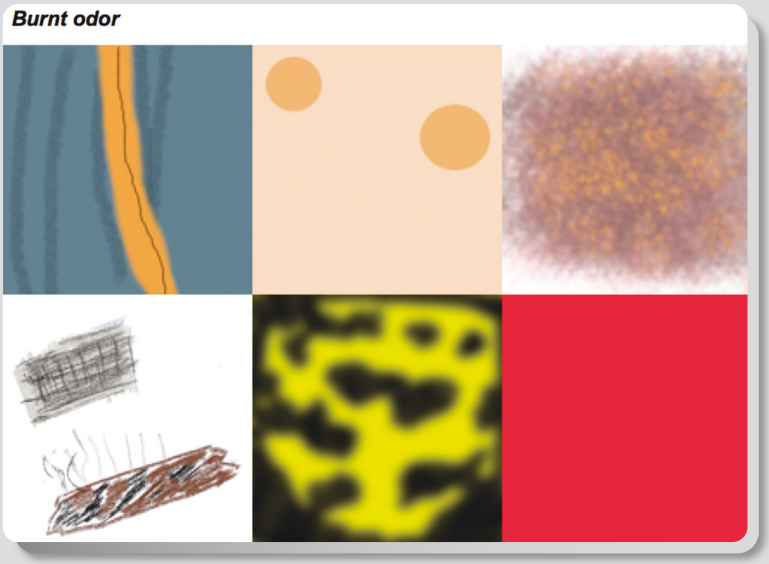
In regards to the role or function of attention in synaesthesia, does it differ with different types of synaesthesia, such as due to saturation, salience, familiarity and the overall state of expectation, rest or boredom? Can we conclude that attention for synaesthetes is significantly different than for non-synaesthetes in any way?

I'm not really sure what the question is here. My work suggests that synaesthesia depends on attention to an inducing stimulus, rather than there being any fundamental difference in synaesthetes' attention relative to non-synaesthetes. We don't yet know if this claim holds for all types of synaesthesia, but certainly in grapheme-colour synaesthesia there is convincing evidence that synaesthetic effects usually do not arise unless the participant is attending to the inducing stimulus.

In one of your co-authored publications, you conclude that "limiting attention or masking inducers tends to reduce or eliminate behavioural evidence of synaesthetic experiences". How can we make sure whether synaesthesia, as you further reason in this article, enhances performance in visual search tasks or is a by-product (spin-off) germinated by synaesthetes' constant salience and acute attention to the inducers?

Yes, when one can't pay attention to the inducer, we do not see evidence of synaesthesia, the inference being attention is probably crucial for synaesthesia to occur. To truly show that synaesthesia can enhance selective processing in a way that would be facilitative for tasks like visual search, where attention could theoretically be guided by synaesthetic colours if they occur, we would need to rule out other higher-level explanations for any advantage. This could include broad effects like motivation, but also more specific high-level cognitive explanations like perceptual grouping by concept (e.g., like when you see a familiar phone number) or more rapid rejection of distractors. For visual search, then, convincing evidence would be:





These figures show some of the range of synaesthetic experiences in response to two odours (caramel *above*, and a 'burnt' odour *below*) from 6 olfactory-visual synasethetes. Reproduced under CC BY 4.0 from Russell et al., 2015

(a) faster and/or more accurate detection of a target that evokes synaesthesia embedded among distractors that do not evoke synaesthesia seen in synaesthetes but not controls in the context of…

(b) baseline tasks that are similarly motivating but for which performance does not differ between the groups (demonstrated with Bayes or similar analyses which can provide evidence for a null effect, not just a non-significant p-value, as this is not able to distinguish between 'no effect' and 'insufficient power to detect an effect').

(c) In addition, a claim that synaesthesia causes 'pop out' requires that setsize (number of distractors) has little to no effect on reaction times. This is crucial to the claim that any synaesthetic effect is due to a pre-attentive synaesthetic colour.

What is your current "pet peeve" most annoying misconception about synaesthesia? What ideas about synaesthesia has your experience of researching synaesthesia made you get rid of? What do you feel is the main thing currently being overlooked or ignored in synaesthesia research?

I have focused on a relatively quantitative view of synaesthesia, looking for commonalities across individuals who experience the phenomenon rather than individual differences. This loses, however, the richness of subjective experience, which has been emphasized by researchers who do individual case studies. We need to ensure that our explorations of synaesthesia include both the richness of subjective experiences and the rigour of objective measurement. Introspection is not the best tool to probe cognitive processes, so I see subjective report as an integral part of developing hypotheses, which then need to be tested objectively in as many synaesthetes as possible so that we can get a picture of what mechanisms underpin the phenomenon and what aspects might be individual.

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Tessa van Leeuwen:

> Studying the commonalities between synaesthesia and autism may make it clearer which role sensory abnormalities play in the etiology of autism spectrum disorders.

Tessa van Leeuwen, Ph.D., is a Research Fellow at the Donders Institute for Brain, Cognition and Behaviour of the Radboud University, Nijmegen, the Netherlands. She completed a Masters in Biology (Neurobiology) and a Ph.D. on the neural mechanisms of grapheme-colour synaesthesia, and was a postdoc with Wolf Singer at the Max Planck Institute for Brain Research in Frankfurt am Main, Germany, studying brain oscillations in synaesthetes and schizophrenia patients. Van Leeuwen does research in cognitive neuroscience, mainly working on synaesthesia. Her synaesthesia-related research focuses on neuroimaging of the brain areas and networks underlying synaesthetic colour perception and on attentional aspects of colour processing in synaesthesia. She also studied commonalities between cross-modal associations and synaesthesia in a large online sample of several thousand participants. Beyond synaesthesia, her research interests and topics are cross-modal processing, connectivity and networks in the brain, and sensory perception in autism. The methods she applied in her scientific research are functional magnetic resonance imaging, magnetoencephalography (MEG), EEG, and online behavioural testing. She currently works on the project 'Visual perception in autism and synaesthesia', studying the commonalities between autism and synaesthesia mainly with regard to perception, both at the neural and phenomenological level. Topics include atypical sensory sensitivity and enhanced perception of details.

How do you define synaesthesia? Is it one phenomenon or several ones?

Synaesthesia is the automatic experience of additional, unusual sensations triggered by specific stimuli (the inducers). The synaesthetic experiences are involuntary, cannot be suppressed, and are idiosyncratic for each individual synaesthete. I believe synaesthesia is one phenomenon, but there are definitely more cognitive and more sensory forms of synaesthesia. Compare, for instance, sequence-space synaesthesia, in which sequences of concepts such as months are expressed as organized in space; or music-taste synaesthesia, in which pure musical tones trigger primary tastes experienced as localized in the mouth (Beeli, Esslen, & Jäncke, 2005). What all forms have in common is the triggering of unusual accompanying sensations that are met with bewilderment by non-synaesthetes.

To what extent is synaesthesia inborn (genetically determined)? What are the causal influences of learning and cognition in its occurrence?

Synaesthesia most often occurs for abstract units or concepts, graphemes and symbols, sequences and other (cultural) items that have been (over-)learned in early childhood (although exceptions exist). Hence, most of the inducers are entities that the brain first needs to familiarize with. This immediately illustrates the powerful influence of the environment on the manifestation of the condition, since everything that needs to be learned first has to be offered by the environment. Thus, when and how intensely you have come in contact with spoken language(s), linguistics units, written letters and numbers, sounds, music, abstract concepts, written musical notes, etc., can influence your synaesthesia (Witthoft, Winawer, & Eagleman, 2015).

This is not to say that genetics are not crucial. On the contrary: a genetic predisposition towards synaesthesia has to be present in order for it to become apparent. In synergy with the genetic make-up, the environment can then influence and determine which forms eventually develop, and which synaesthetic associations are formed. There is accumulating evidence from genetics studies that there is not

one single gene or one single set of genes that is responsible for synaesthesia. Instead, multiple different gene variants have been identified in different families, and many associated genes are involved in axonogenesis and other processes related to communication between neurons, and brain organization (Tilot et al., 2018). Since there are large individual differences between synaesthetes, for instance in the level of hierarchical processing of the inducers before triggering a synaesthetic association (van Leeuwen, 2013), it is likely that differential expression of synaesthesia-associated genes influences the final perceptual phenotype of individual synaesthetes.

In what ways is synaesthesia an advantageous, an impeding and a neutral condition?

I am convinced that, if synaesthesia would be strongly impeding, it would not be so common (2-4% prevalence). Many variants of synaesthesia are relatively mild, such as sequence-space or grapheme-colour synaesthesia, which are mostly experienced as beneficial and as helpful for memory. Of course, synaesthesia can be impeding if it becomes too prominent in daily life, the experiences are overwhelming, and cannot be avoided (e.g., strong synaesthesias for environmental sounds or spoken language). It can lead to hyperstimulation of the senses and sensory overload, which may make it difficult to take on an active, participating lifestyle. As far as I know, however, these negative cases are relatively rare, and synaesthesia can generally be regarded as mildly beneficial.

Are people with synaesthesia special in any other way? Do all people have synaesthesia to some extent?

People with synaesthesia are not more special than any other individuals: all people differ in their perception of the world, their experiences, their preferences, and in their sensory processing. Synaesthesia is just one way of being individually different. Synaesthetes' tendency to connect the senses may contribute to their creative or artistic nature, but this is not true for all synaesthetes (if I may speak for myself, as a non-artistic grapheme-colour synaesthete).

Not all people have synaesthesia to a certain extent, if synaesthesia is defined to mean a conscious experience of the concurrent

synaesthetic experience. Crossmodal associations, however, are common to all of us and these less specific, more intuitive associations can strongly resemble synaesthesia (for instance, associations of colours for letters or colours to tones in non-synaesthetes follow similar patterns to those in synaesthetes). Also, individuals differ in the strength of these crossmodal associations (Cuskley et al., 2019; Burghoorn et al., 2019), which does suggest the possibility of a 'synaesthesia continuum'. Synaesthetic experiences also adhere to general crossmodal tendencies such as connecting high pitched tones with bright colours and lower pitch tones with darker colours (Ward, Huckstep, & Tsakanikos, 2006).

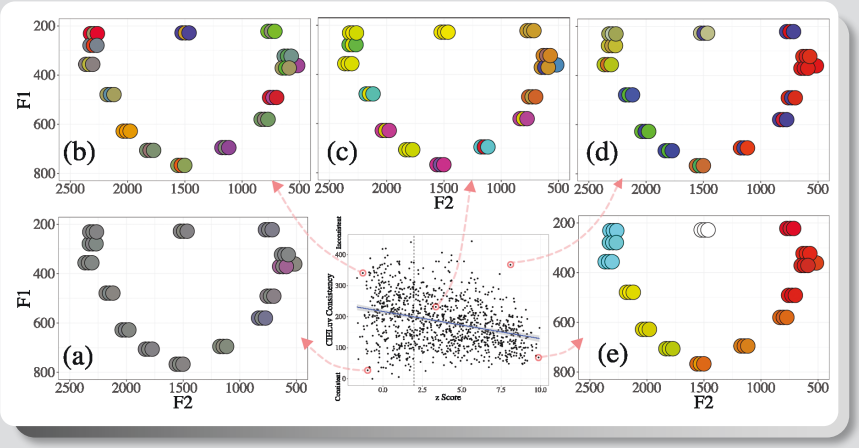
What is your story (and impression) of reading Alexander Luria's *The Mind of a Mnemonist*?

It made me realize which extreme forms synesthesia can take, and what a huge impact it can have on cognition and memory, even though it is usually a mild and sometimes even unnoticed condition. Of course, the case of S. is a savant exception, but nonetheless, the human brain is capable of these extraordinary things. Individual case studies are powerful tools and whenever someone approaches me with their personal story about their exceptional synaesthesia, this inspires me to think of the possible mechanisms the case study could help to elucidate.

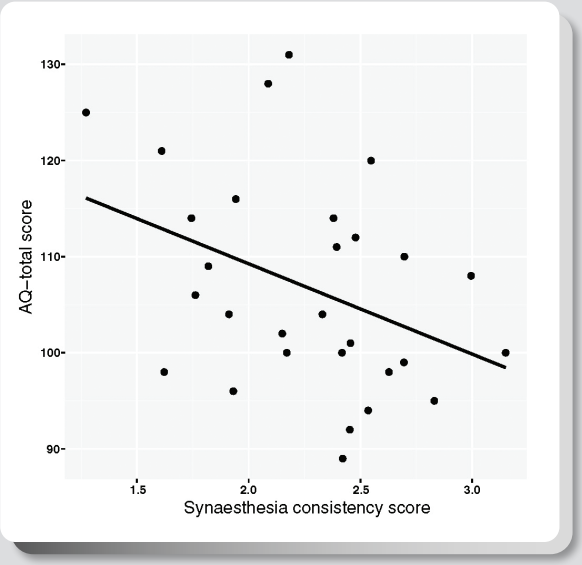
Why is it important to do research into synaesthesia? What are its promises for cognitive science or science at large?

Synaesthesia is a perceptual phenotype: a specific way of perceiving the world that is enabled by the ways the brains of synaesthetes operate. If we understand what causes this aberrant perception, we learn more about how the brain processes incoming information and which factors are important for becoming consciously aware of the world around us. Is it a difference in weighting bottom-up input (sensory information) to the brain, or an ingrained difference in expectations (prior knowledge) that drives synaesthetic perception (van Leeuwen, 2014)?

Given its high prevalence in autism spectrum disorders (Neufeld et al., 2013; Baron-Cohen et al., 2013), it is my explicit hope and also



Mappings of individual participants, clockwise from bottom left—(a) a participant with very low structure yet high consistency across trials and items, probably indicating a false positive synaesthete, (b) a typical non-synaesthete with inconsistent and unstructured mappings, (c) a middling participant with significant structure but inconsistent choices across trials, (d) a highly structured but inconsistent participant, and (e) a typical vowel-colour synaesthete, with highly structured, consistent and categorical mappings. Reprinted under CC BY-SA 4.0 from Cuskley et al., 2019



The graph illustrates the relation between Autism Quotient sco-res and synaesthesia consistency scores in the general population. Reprinted under CC BY-SA 4.0 from Burghoorn et al., 2019

my expectation that synaesthesia research will contribute to a better understanding of sensory dysregulations in autism in the upcoming years. Autistic traits are enhanced in synaesthetes, especially those related to perception (Ward et al., 2017; Ward et al., 2018; van Leeuwen et al., 2019), and synaesthesia consistency scores and autistic traits co-vary in the general population (Burghoorn et al., 2019). Studying the commonalities between synaesthesia and autism may make it clearer which role sensory abnormalities play in the etiology of autism spectrum disorders.

As a special perceptual phenotype, synaesthesia contributes a case-model of sensory perception to science at large.

Several of the publications that report the results of your research deal with the neurophysiologic peculiarities of colour perception in grapheme-colour synaesthetes. What is difference in colour perception between synaesthetes and non-synaesthetes? Why is colour so special in this type of the phenomenon? Is a synaesthetic blue, for examples, the same as a veridical blue?

In basic colour perception, synaesthetes and non-synaesthetes do not differ. It has been reported that grapheme-colour synaesthetes are better at remembering colours and perceiving small colour differences (Yaro & Ward, 2007; Banissy et al., 2009); this is most likely because of their life-long experiences with colour. There is evidence that, in synaesthetes, the parvocellular visual system is overactive (Barnett et al., 2008; van Leeuwen et al., 2013). This is the visual system that is important for perceiving colour and details. If the parvocellular system is very sensitive, and perhaps hyperexcitable (Terhune et al., 2011), and if it is then processing spatial detail such as letters, perhaps the neurons that process colour are also activated by chance. I believe the wiring of the visual system and its topographic organisation is one of the reasons why so many synaesthesias are concerned with colour. I believe a synaesthetic blue is processed in the same visual system as veridical blue; however, synaesthetes are very much aware that their synaesthetic colours are not 'real' (Seth, 2014), and thus synaesthetic and veridical blues are not exactly the same.

You stated that synaesthesia "most often occurs for abstract units or concepts, graphemes and symbols, sequences and other (cultural) items that have been (over-) learned in early childhood (although exceptions exist)", and "a genetic predisposition towards synaesthesia has to be present in order for it to become apparent". How do you see drug-induced synaesthesia and/or synaesthesia resulting from injury (e.g., an epileptic episode, a bullet wound, or a tumour) operating in this system or differing from congenital synaesthesia?

In case of developmental synaesthesia, I believe this is mediated by genetic factors such as differences in axonogenesis (Tilo et al., 2018) or differences in other signalling mechanisms of the brain that already occur early during development. This genetic predisposition allows for the development of stable synaesthetic experiences, the exact nature of which are under influence of the environment (e.g., fridge magnets) (Witthoft & Winawer, 2006; Witthoft et al., 2015).

Drug-induced synaesthesia stimulates connections between the senses that are present in all of us. Drug-induced synaesthetic experiences are not as stable as developmental synaesthetic associations — i.e., if you take the same drug twice you do not necessarily see the same synaesthetic experiences twice (Terhune et al., 2016). This is not to say that the connections between the senses that are present in all of us are completely and qualitatively different from what happens in synaesthesia. I do not exclude disinhibited feedback as a mechanism of synaesthesia. But in developmental synaesthetes, the altered balance in certain brain circuits is innate (mediated either through differential axonal connections or through differential brain circuits) and stable over time.

Synaesthesia that is induced through injury is often different in nature from developmental synaesthesia in that it involves more basic sensory experiences. Injury can affect connections between brain regions and induce altered communication and altered brain circuits through adaptation; in that sense it is very likely that induced synaesthesia is largely explained by the same mechanisms as developmental synaesthesia.

How do you explain the neurological mechanisms of synaesthesia if pressed for a bootstrap answer? What scientific model of congenital synaesthesia based on hard data do you subscribe to?

I subscribe to a model of hyperexcitability in the brains of synaesthetes, which alters neuronal dynamics and mediates aberrant perception. As mentioned above, if the parvocellular system (for instance) is very sensitive, and if it is then processing spatial detail such as letters, perhaps the neurons that process colour are also activated by chance. Or, if graphemes are coloured in the environment, this colour is processed more deeply by the hypersensitive parvocellular system. In both cases, the specific pattern of activity including activity in the colour neurons may become engrained as the prior that constitutes the letter (van Leeuwen, 2014). Of course, such mechanisms of hyperexcitability can also occur in other sensory systems, for instance the tactile mirror system (Bolognini et al., 2013).

Which (genetic) mechanism mediates the hyperexcitability and how hyperexcitability in the end leads to strong priors (van Leeuwen et al., 2018) in synaesthesia (compensatory mechanisms?) is something for future studies of the mechanisms of synaesthesia.

Have you had experiences with synaesthete "wannabes"? If so, what have been your reactions to wannabes? Is there any particular case which stands out for you?

I have had no such experiences. There have been several people who experienced phenomena that resembled mirror-touch synaesthesia but who were mainly strongly emphatic to their environments and lacked the physical component of mirror-touch synaesthesia. We have kindly explained to them that our study was about the type of mirror-touch synaesthesia that included physical sensations.

To what extent, and how and why, did the fact that you yourself are a synaesthete influence your decision to research synaesthesia? And do you think being both gives you an advantage in studying the phenomenon?

I found out that I was a synaesthete when I was about 20. I was in a vision lab, and one of the assistant professors in the lab came back from a conference with a story about coloured hearing. Coloured hearing did not ring any bell to me, but when he explained that it could also occur for written letters, I realized that I was also a synaesthete. This sparked my interest and, for the completion of my Master's, I wrote a literature review about the topic. What I like about synaesthesia is that it deals with the question of how we subjectively perceive the world, and all the individual differences thereof; to study such a subjective phenomenon with neuroimaging methods and to try to understand it is a wonderful challenge.

I only have grapheme-colour synaesthesia. In some ways it helps to be a synaesthete because you do understand other grapheme-colour synaesthetes a bit better. There is a certain intuition about what it is like for them and what synaesthetic colours are and what they are not. On the other hand, it can also make you blind to alternative forms of synaesthesia or individual manifestations that do not match with my own experience. Of course, there are many forms of synaesthesia that I do not have: I am objective about those and as fascinated by these experiences as non-synaesthetes are.

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Dina Riccò:

> Our perceptive capacities are more "nuanced", articulated and various; perhaps the distribution of the subjects on a synesthetic scale would be more realistic.

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How do you define synaesthesia?
Is it one phenomenon or several ones?

The word synaesthesia has changed its meaning over time: from its appearance in the texts of the ancient philosophers, with the expression συναισθανεσθαι (synaisthanesthai) of Aristotle, in the form of a verb and not yet a noun, which follows the meaning of Castellus's (1746), of *Synæsthesis* as an awareness of the disease. Then, from the definitions present in scientific production, especially in the medical field, and the dictionaries of the second half of the nineteenth century, up to today's application contexts, the meaning of the word synaesthesia has undergone dilation and delimitation over time.

This is inevitable; a word changes, is transformed, takes on multiple meanings, in parallel with the evolution of the theories that accompany the concept. If we consider the last 150 years, from the definition of Littré (1872), to that of twenty years later and more extensive than Millet (1892), until today's applications, we note that the meaning of the word synaesthesia has progressively widened, thanks also to the progressive explosion of scientific production on the subject.

The semantic expansion of the word begins with the concept of synaesthesia understood as "sensations associées" by Millet (1892) and in Italy with the concept of "bello sinestetico" ["beautiful synaesthetic"] by Pilo (1894, 1905). I think this is an important moment in the evolution of the term because it leads from synaesthesia as a phenomenon that identifies a perceptual character or specificity of the **subject**, of the individual, to synaesthesia as a character instead of the **object**, something that is no longer just *psychic* or *physiological*, but *physical*.

Considering this extended meaning of synaesthesia — combined with the study of the concept in various disciplinary fields, from neurosciences to the arts, to music, to design — I have come to distinguish three types of synaesthetic manifestations:

1. Synaesthesia as a perceptive phenomenon (the Synaesthesia proper);
2. Synaesthesia as a linguistic expression (e.g., metaphors);
3. Synaesthesia as a representation or as a "practice" (what Dufrenne calls "pratique synesthésique des arts", 1991).

Three distinct manifestations of synaesthesia; this does not exclude that they can also be concomitant. I think the difficulty, and the differences in definition between the different theories, are not so much in defining what synaesthesia is, but who/what is synaesthetic and who/what is not synaesthetic. In particular, I find the postulates formulated by Tornitore (2000) useful; he believes that a synaesthetic phenomenon to be defined as such must include:

1. the "coexistence of two or more sensory domains (senses and/or sensations), real or virtual";

2. "between the aforementioned heterogeneous sensory domains there must be a type of synthesis link (from analogy to identification), and not of accumulation or parallelism".

The indications of these postulates are not trivial; in fact, we find studies in which they are mistakenly called synaesthetic phenomena, in which inducing stimulation and image induced belong to the same sensory register. This, by definition of synaesthesia, is not correct. So, I agree with an extended sense of synaesthesia; but I believe that more rigor is needed in determining what is, and what is not, synaesthetic.

To what extent is synaesthesia inborn (genetically determined)? What are the causal influences of learning and cognition in its occurrence?

I believe that synaesthetic phenomena contribute to both innate factors the cases of striking synaesthetes such as the one described by Luria demonstrate this, as well as other studies conducted on newborns; see for example the study by Meltzoff & Borton (1979) — and are acquired with learning. We find studies supporting both of these factors.

I think rather that the types of synaesthetic correspondences have a different origin. In this sense, the taxonomy that Walker-Andrews (1994) makes of intermodal relations seems to me to be explanatory; they can be: 1. amodal information; 2. artificial/arbitrary relations; 3. arbitrary/natural relations; 4. typical relations.

The *typical relations* between characters of different sensorial registers are undoubtedly influenced by experience. The *amodal information*,

which echoes the concept of *common sensorum* of Aristotle and of the unity of the senses we have seen addressed in Hornbostel (1925), Werner (1934), and Marks (1978), can presumably be understood as innate. The *artificial/arbitrary relations* are the work of man, of the designer, therefore not innate, even if the particular associative choices of the designer could respect the *amodal correspondences*. The *arbitrary/natural relations* are learned, even if in a natural context (for example, the association of a voice with a face).

In what ways is synaesthesia an advantageous, an impeding and a neutral condition?

Reading Luria's *The Mind of a Mnemonist* would lead one to think that synaesthetic perception may be considered an impediment to other cognitive and thought activities; but I think this is true only in particular subjects, and in particular levels of synaesthetic training.

For the generality of the subjects, I think that synaesthetic awareness can instead be a beneficial condition, especially for creativity. For this reason too, the relationship between synaesthesia and art has fascinated scholars, and some works by artists and musicians — we think of Kandinsky, Scriabin, and many others — are considered paradigms of synaesthetic expression. In this sense, I believe that the study of sensorial correspondences of synaesthetes can help to design communicative artifacts whose information is sensorially congruent.

Are people with synaesthesia special in any other way? Do all people have synaesthesia to some extent?

Also in this case, the reading of Alexander Luria's *The Mind of a Mnemonist* would lead one to answer that synaesthesia is a "special" ability. For some people, synaesthesia is actually "special", as it is extremely developed, and constantly present; however, I think synaesthesia is a "normal" phenomenon. I agree when Merleau-Ponty (1945) states that "La synesthésie est la règle", it just occurs in people at different levels of intensity and types. Marks (2009, 2011) talks about "vivid synesthesia", a form that we find present in a few individuals; and, taking up the terminology of Osgood (1960) of "synesthetic tendencies",

we find these in the generality of individuals.Here, I believe these are central concepts to help the community of scholars to order and define a shared theory of synaesthesia. In essence, to my thinking, synaesthesia is a *multiform phenomenon*, and is also present at *different levels* of intensity (vividness) in the generality of individuals.

What is your story (and impression) of reading Alexander Luria's *The Mind of a Mnemonist*?

My impression is partly expressed in the two previous answers. In general, the book, and Luria's research, are the amazing proof that the mind has no limits. Reading the book also leads to more general reflections, not strictly related to synaesthesia: namely, the relationship between the imaginary world and the existing world, between physical reality and imagined reality. It reminds me of a particular dialogue of the science fiction film *The Matrix* (1999), in which Morpheus, one of the protagonists, says "What does it mean, real? Give me a definition of real. If you refer to what we perceive, to what we can smell, touch and see, that real are simple electrical signals interpreted by the brain."

For man, the real world is the phenomenal world, the world that is aware of perceiving through the senses. In fact, to Mr. S., the difficulties emerge when the imaginary world, the mental images that are so "blinding" in him, come into conflict with reality, blocking the possibilities for action.

Why is it important to do research into synaesthesia? What are its promises for cognitive science or science at large?

I particularly study the relationship between synaesthesia and design, specifically the functions of the synaesthetic project, intended as a project that pays attention to the relationship and the coherence between sensory information, in which the current meaning of synaesthesia as "simultaneous perception" is united with the Aristotelian one of effective perception and awareness of perceiving. In this conception, I think that research on synaesthesia, and the synaesthetic project, can be useful, in particular for the following: 1. to design effective communicative

artifacts, in which the information between the different sensory registers is coherent with each other; 2. to design communicative artifacts accessible to all, including users with sensory disabilities.

A vicarious sense can take the place of a missing sense, or that particular non-functioning condition, if activated for synaesthesia. We know that this is physiologically possible. Studies conducted in neuroscience, using brain visualization techniques — see the works of N. Sadato (et al., 1996), Krish Sathian (1999), and Oliver Sacks (2003) — show how much the brain is plastic, and how, for example, a tactile stimulus can activate the visual cortex, to produce visual mental images even without corresponding stimuli. This happens in blind people, who remodel the lost capacity in other senses; but the same happens for those who are temporarily "blind", i.e., when they are blindfolded, while performing a tactile task. Therefore, the ability to define synaesthetic correspondences with intersubjective validity would facilitate the project of effective communicative artifacts.

A second area in which the study of synaesthesia is important, for those involved in design and training of designers, is a function of creativity, in teaching activities and training a creative attitude that has the awareness of synaesthetic perception. Also, in this case, what for us it would be important to define, and therefore to have an answer, is essentially what synaesthetic correspondences, which characters, in which sensory registers, do we recognize as an intersubjective validity.

Regarding pedagogical methods, how do you help students distinguish and discriminate between cross-modal correspondences and synaesthesia? What do you explain about synaesthetes' potentials? Who of the world-famous artists and composers do you consider true synaesthetes?

I state I consider it improper to divide the subjects clearly between *synesthetes* and *non-synaesthetes*. Our perceptive capacities are more "nuanced", articulated and various. Perhaps the distribution of the subjects on a 'synesthetic scale' would be more realistic, at whose extremes there are rare conditions: on the one hand the total absence of synesthesia (I assume rare) and on the opposite side the high

synesthesia (equally rare; see for example the case of Mr. S. described by Luria). While at the center there are hybrid conditions of various synesthesia intensity.

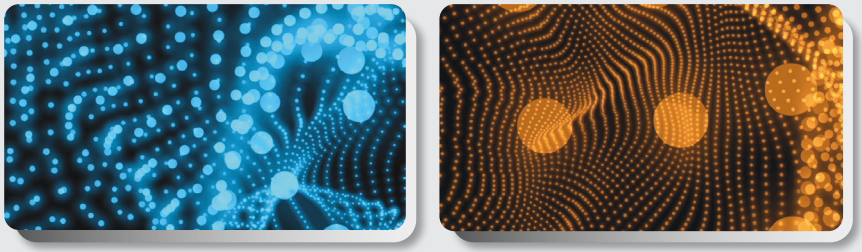
Students usually do not distinguish the differences between the concepts of *synaesthesia* and other related terms, such as *cross-modality*, and even the more general *multisensory*. To explain the concept of synaesthesia to students, first of all I describe the historical case studies, taken from Lussana (1873) and Lemaître (1901), observed on students. I also describe the particular case observed by Luria, and recently the classification of the types of synaesthesia present in the book by Sean A. Day, *Synesthestes* (2016). In a second phase, I propose practical exercises.

In general, I propose two types of exercises to help students gain greater awareness of the cross-modal relationships and the intersubjectivity characters of certain sensory correspondences.

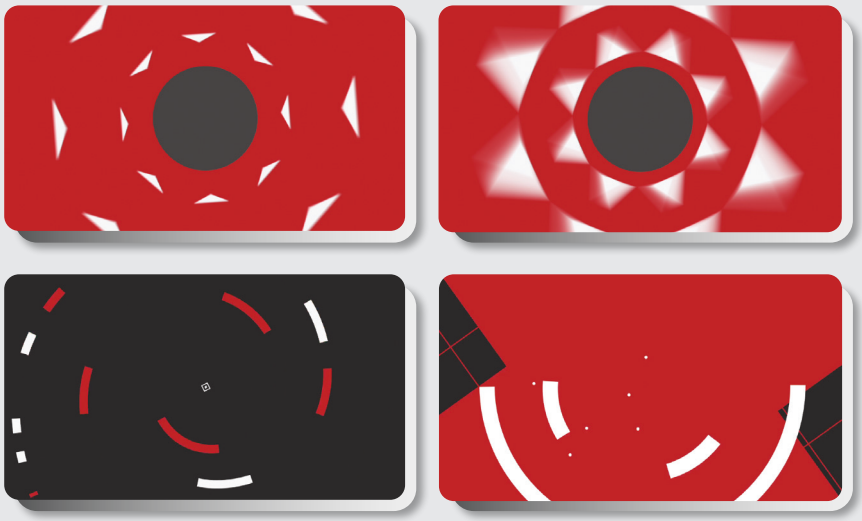
1. A first group of tests — which I call of *synesthetic interobservation* — consists in listening to some (2–3) pieces of music extracted from audio / video footage, and in the recognition of the visual correspondence between some (2–3) animation videos (without audio) presented. A brief description of this exercise on Fischinger's films can be found in my book *Sentire il design* (2008).

2. A second group of exercises, on the other hand, requires a greater effort; that is, not only choosing or coupling a visual, but also conceiving, representing, visualizing, a sound / musical content. This generally meets greater difficulty for students: it is simple to synchronize a visual with a sound; it is much more difficult to find the right shape and even more (for the subjectivity of correspondences) the right color. This is what we did for example at the last conference of the Artecittà Foundation in Alcalá la Real, Spain, 2018, with a video project presented for the *Boléro event* conceived by Ninghui Xiong.

These experiences lead students to have a greater awareness of the interactions between sensory registers, and the difficulties of visual mental representation of a musical content, but also of the intersubjectivity of some audio / video correspondences. The figure of the artist who best represents for me the synaesthete subject is the Swiss



Two frames from the video *Baba-Yaga*, synaesthetic translation of composition *Pictures at an exhibition* by Modest P. Mussorgsky — produced by the students of the "Appliances and complex systems design studio" (Politecnico di Milano, Design School, A.Y. 2010/2011). Directors, professors Dina Riccò and Antonio Belluscio, with the collaboration of teaching assistants Gian Luca Balzerano, Alessandro Zamperini. Provided by Dina Riccò



Four frames from the video *Boléro 2018*, synaesthetic translation of composition *Boléro* by Maurice Ravel, produced for the exhibition *Boléro* (ed. by Ninghui Xiong et al.) — part of the *VI International Congress Synaesthesia, Science & Art* — by the students of the "Appliances and complex systems design studio" (Politecnico di Milano, Design School, A.Y. 2017/2018). Directors, professors Dina Riccò and Gian Luca Balzerano, with the collaboration of teaching assistants Alberto Barone, Giulia Martimucci, Alessandro Zamperini. Provided by Dina Riccò

painter — as well as graphic designer, animator and amateur musician — Charles Blanc-Gatti (1890–1966). The graphic and chromatic characters of his works, which among other things frequently have musical titles, his "vision" of the music, correspond well to the descriptions of the percepts we find in the case studies on synaesthetes. Another author that I always present to my students is Oskar Fischinger (1900–1967), regarding whom, although he does not have a certain testimony of "true" synaesthetic perception, the visual kinetic translations of musical pieces, the audio / video synchronization, the high abstraction of the compositions, well represent the visual characters of the synaesthetic percepts.

In terms of integrating synaesthetic aspects to modern architecture, looking at the latest computer and digital technology, what do you feel is the biggest mistake people (e.g., students) are making?

What I observe in my Design students at the Politecnico di Milano is the difficulty to break away from the configurational limits of digital techniques. That is, the difficulty in thinking about something that cannot be done, or I cannot do (draw), with the computer. *Technical ability* strongly affects *creative ability*. I am not referring to the result; in all ages, the quality of the final artifact is conditioned by the technical ability. I refer instead to the predisposition to experiment with new techniques: they seem, for the students, to be all filtered by the screen and its limits, forgetting other analogical and material possibilities.

Today's digital technology allows an anticipation, and a forecast, of the constructive and design results, much more advanced than in the past, but we find it more difficult to go beyond the known technical limits. Digital technology expands the possibilities, but at the same time "limits" extradigital experimentation, and in some aspects also creativity.

Regarding your understanding of the influence of culture on the sensorium and culture-related specifications of the synaesthetic models, do you think that synaesthetes are people with novel, advanced capabilities or those who retained this phenomenon throughout the course of evolutionary changes?

I think that the environment, the culture and the technologies influence our sensorial response and consequently that the quality (or the subjects / objects) of the perceptions of the synaesthetes change accordingly. However, the detectability of new skills is conditioned by the way we study these skills, recognize them and catalogue them. That is: if the definition of synaesthesia that we apply today is the same as applied a century ago, it becomes more difficult to recognize diversity, what has changed, and what are the new capabilities.

If sensoria (models of cross-modal correspondences) change throughout history and seem geographically and culturally modifiable, too, do different sensoria generate irreconcilably different ways of meaning-making? What is special about modern western culture in terms of the interrelation of the senses and related meaning-making? (How) can we answer the question of what it is like to be a synaesthete?

The peculiarity of modern culture I think is to be found in *invasiveness*, *immersiveness*, real / virtual *hybridization* of digital technology that, on one hand, differs from materiality, from physicality, with its own sensorial qualities, and, on the other, *simulates sensations*.

The result is that, in the quantity and variety of sensations — both real and simulated — everything becomes more difficult to distinguish, not only between real and simulated, but also in the specifics of the qualities of sensations. For example, what is *visual* and what is *tactile* in an image that I touch on the screen? I could equally say this for printing techniques that simulate, sometimes reproduce, tactile qualities: the cover of a book is "to be seen" in the bookshop, but new printing techniques increasingly invite "to touch".

It is much more difficult (compared to the pre-digital age) to distinguish the limits between the sensory registers and always stronger that *The Unity of the Senses* so lucidly intuited by Marks (1978). We therefore return to the central question: what does it mean to be a synaesthete? I think we should once again confront each other and propose an updated definition that considers the mutation of the perceptual experience produced by digital technologies.

Being a non-synaesthete yourself, would you want to have synaesthesia? If so, which type of synesthesia would you most like to have, towards doing research on yourself?

In effect, if we have as reference to "true" synaesthesia, cases like S. described by Luria, I am not a "true" synaesthetes, I have nothing of constancy, of vivacity, of the memorability of such perceptions. However, I consider myself synesthetic in the meaning of Merleau-Ponty when he says "La synesthésie est la règle", or some correspondences (e.g. colors / smells) disturb me and in general I can not help but connect, and merge, perceptions from one sense to another. Anyway, yes, I would like to experience the emotion of what we call "true" synaesthesia.

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Solange Glasser:

> The extensive variability of experiences in response to music that synesthetes report reveals that we still have much to learn about each of our unique interpretations of the music that we engage with on an often daily level.

Solange Glasser, Ph.D., is a Lecturer in Music Psychology and Performance Science at the Melbourne Conservatorium of Music at the University of Melbourne. Glasser began her tertiary education by studying violin performance and musicology at the Queensland Conservatorium of Music, where she published her Honours thesis under the title *Music, the Brain, and Amusia*. In 2004, she was accepted into the musicology program of the University of Paris IV, Sorbonne, France, where she successfully completed a Licence and Masters in Musicology, publishing her Masters mémoire under the title *La synesthésie équivoque d'Olivier Messiaen* (*The Ambiguous Synaesthesia of Olivier Messiaen*). She went on to complete a one-year Diploma of Orchestral Conducting at the Municipal Conservatorium of Paris XIX, under the baton of Emanuel Jaeger. After spending over a decade in Paris, Glasser moved to Melbourne to undertake her doctoral studies at the University of Melbourne under the supervision of Gary McPherson. She completed her Ph.D. in 2018 and was awarded the *MCM Director's Writing-Up Award Scholarship for Exceptional Doctoral Research* for her dissertation entitled *The Impact of Synaesthesia and Absolute Pitch on Musical Development.*

How do you define synaesthesia? Is it one phenomenon or several ones?

As a musician, I have always been fascinated by how the brain processes and reacts to music. It was early on in my research career that I was first exposed to discussions concerning 'synaesthesia': a neurological condition in which the stimulation of one sense modality leads to an automatic and involuntary experience in a second sense modality. Synaesthesia was regularly mentioned in articles I read and lectures I attended over the coming years, particularly when discussing specific composers who reported having, or were believed to have, synaesthesia. These reports were almost exclusively anecdotal: synaesthesia was often spoken of with fascination, and yet was treated as a 'quirk' or eccentricity of little experiential importance. As such, the potential effects of the condition on musical perception, production, or development, remained unaddressed.

I view synaesthesia as one condition, that nonetheless lies along a continuum. It can therefore vary in strength, as well as varying considerably in its manifestation and the different forms it takes. As a music psychologist, I am particularly interested in music-related forms of synaesthesia, which include forms of synaesthesia induced by musical notes, sounds, instruments or tonalities, and which induce colours and shapes, tastes, textures, or spatial coordinates. As with other synaesthetes, musician-synaesthetes often possess more than one form of music-related synaesthesia, and these forms interact in complex ways when synaesthetes engage with music, whether that be when playing, listening, or composing music.

From the perspective of your research as a music psychologist, to what extent is synaesthesia inborn (genetically determined)? What are the causal influences of learning and cognition in its occurrence?

We know that while synaesthesia runs in families, the types of synaesthesia, or indeed the precise correspondences between senses or sense modalities, does not. These findings indicate the existence of a genetic predisposition for synaesthesia, but also imply that precise synaesthetic

correspondences could be developmentally or environmentally mediated. One key aspect of the results obtained in my research on music-related forms of synaesthesia is their participant-specific nature (Glasser, 2018). The richness of the data I have collected is contained in the individuality of the life stories of the musician-synaesthetes I have interviewed, as these interviews reveal personal vignettes concerning each musician's unique development. The results do not illustrate homogeneous reactions or outcomes among participants. What they do show, however, is a multiplicity of outcomes, enhancements, and changes at the individual level. This is important, as a behaviourist interpretation of this data is therefore untenable, with no single outcome-specific thread established. At both a cognitive and affective level, a complex and individualised profile can be drawn for each musician-synaesthete. Indeed, even comparable behavioural manifestations are the product of specific underlying internal mechanisms; these behaviours are thus indicators of a multitude of different cognitive-affective sources.

In what ways is synaesthesia (and especially of the music-related types) an advantageous, an impeding and a neutral condition?

One of the main aims of my research is to identify the degree to which the possession of synaesthesia may facilitate or impair the cognitive, affective, and behavioural outcomes of musical development (Glasser, 2009, 2014, 2016, 2018), and to investigate the potential interaction between synaesthesia and other related conditions, such as absolute pitch (AP), for participants who possess both conditions (Glasser, 2018). Absolute pitch is the ability to label a musical note without reference to any other note, and while the co-occurrence of certain types of music-induced synaesthesia and AP is indeed reported, any interaction between these two conditions remains highly speculative and lacking empirical foundation. Thus, in order to fulfil these objectives and answer these and other questions, I use a mixed-methods approach, including online surveys, face to face interviews, and synaesthesia and AP test batteries.

The high incidence of synaesthesia among artistic professionals and people with creative hobbies has been confirmed in a large-scale study by Rich and colleagues (2005). This study established that 24% of the synaesthetes questioned were professionally engaged in the arts, in comparison to a general population rate of only 2% (Hochel & Milán, 2008). Other studies have also shown similar results (Cytowic, 2008; Domino, 1989; Niccolai et al., 2012; Ramachandran & Hubbard, 2001). A study of arts students found that 7% of the sample were synaesthetes, compared to 2% of the control sample (Rothen & Meier, 2010), suggesting that synaesthesia may be more prevalent in arts students, thus tying in with previous research into the higher prevalence of arts professionals within the synaesthete population. These studies have led to suggestions as to the possible links between synaesthesia, metaphor, creativity, and the origins of language (Domino, 1989; Ramachandran & Hubbard, 2001; Sitton & Pierce, 2014). Apart from professional engagement, Niccolai and colleagues (2012) further indicated that 68% of the respondents in their study were artistically active, and an interest in the arts was frequently reported. Moreover, 78% of participants indicated that their synaesthesia was an advantage in creative jobs, memorising, learning, or calculating. Participants further described themselves as skilled at painting, learning, foreign languages, and memorisation. On the contrary, participants in the same study reported poor abilities in mathematics, tasks involving sustained concentration, spatial imagination, and spatial perception.

While the best known and most widely studied form is grapheme → colour synaesthesia, less research has explored the neuroanatomical basis of other forms, including music → colour synaesthesia (but see Zamm, Schlaug, Eagleman, & Loui, 2013). Recently, data collected by neuro-imaging techniques employed during the synaesthetic experience clearly validate idiopathic synaesthesia as a real phenomenon and differentiates it from imaginative mental imagery. This validation has led interdisciplinary research to debate whether idiopathic synaesthesia can actively contribute to an artist's ability, and whether synaesthesia can be understood as a motivational force for the synaesthete

artist. This distinction of the synesthete brain may prove to be a window into a neural basis of creative cognition, which may in turn prove conductive to various forms of creative expression (Mulvenna, 2007).

Apart from general studies of synaesthesia, creativity, and artistic ability, there is a paucity of studies specifically looking at the influence of synaesthesia on musical abilities. There are two explanations for this. First, research into the effects of synaesthesia on general abilities have focused on language and learning. This is partly because the most prevalent form, grapheme → colour synaesthesia, lends itself particularly well to this exercise, and also because language is habitually considered of greater importance than other possible areas of research. Second, the study of graphemes is relatively easy in comparison to the study of music in movement, which would engender, for example, colours in movement. It should also be noted that while the semiotics of graphemes and similar symbols are widely known and accepted among the general population, the study of synaesthesia and musical abilities would require a certain level of understanding of musical terminology by the synaesthetes themselves.

In my research, which is specifically focused on music-related forms of synaesthesia, I have formulated a cognitive-affective-behavioural model of musical development to provide a framework for the organisation of the results I have collected. These results indicate that synaesthesia — as well as related conditions such as AP — initially impact musical development at a cognitive level, by enhancing memory encoding and multimodal mental imagery. Enhancements in these domains exert a developmental influence on affective states, specifically motivation, identity, and emotion. These affective outcomes influence musical behaviour, notably choices, preferences, and performance. Both enhancements and limitations to cognitive, affective, and behavioural outcomes were recognized by synaesthetes and AP possessors as being influenced by the possession of synaesthesia or AP. Ultimately, however, all of the synaesthetes and AP possessors that I have studied indicated they would retain their condition(s) if given the choice, with advantages greatly outweighing any negative aspects.

Besides what you said above, are people with synaesthesia special in any other way? Do all people have synaesthesia to some extent?

The findings of my studies and explorations of music-related forms of synaesthesia challenge the notion that research can examine auditory processes of music perception independently of the other senses, particularly vision. Instead, I conjecture that synaesthesia is a multisensory representational system that enhances our understanding of the rules that underlie the interaction of our senses at an experiential level. While this interactive process is conscious for synaesthetes, it is possible that it might also operate unconsciously in non-synaesthetes. If correct, this would serve as an important reference point for future research in both musicology and psychology. What's more, unravelling the unique musical experiences of the synaesthete musicians I have had the privilege of studying has highlighted the distinctiveness of each of our subjective experiences with music. The extensive variability of experiences in response to music that synaesthetes report reveals that we still have much to learn about each of our unique interpretations of the music that we engage with on an often daily level.

Synaesthetes form a distinct and exceptional group, yet they experience the same degree of within-group variation as would be expected in the non-synaesthete population. They are therefore both unique and the same. For synaesthetes, however, there is a greater complexity of information processing at an experiential level. Ultimately, the unique perceptual experiences of synaesthetes develop longitudinally into enhancements in creative cognition, including visualisation, concept formation, categorisation, and memory. My research suggests that, over time, synaesthesia can substantively modify the identity and worldview of synaesthetes, resulting in considerable behavioural changes, including both enhancements and impediments.

What is your story (and impression) of reading Alexander Luria's *The Mind of a Mnemonist*?

What *The Mind of a Mnemonist* achieves is to bring to light the lived-world experience of a person of exceptional ability. This is not simply

a fascinating case study; rather, it exposes the upper limits of human cognition and ability. But what this book also starkly highlights is the constrains and difficulties that such ability can engender. This therefore raises the oft-debated question as to whether exceptional ability necessarily cohabits with deficits in other areas. While this is still an open question, *The Mind of a Mnemonist* and accounts such as those by Luria have paved the way for future research into the subject.

Why is it important to do research into synaesthesia? What are its promises for music psychology, cognitive science or science at large?

It has been proposed that "nature reveals herself through exceptions" (Cytowic & Eagleman, 2009, p. 246), and thus synaesthesia — and similar conditions such as AP — are not simply 'fascinating' conditions; rather, they highlight the idiosyncrasy of each of our subjective perceptions of music. By studying the impact of synaesthesia and AP on musical development, we can elucidate a number of fresh insights into these two conditions, their interaction, and what they may reveal about musical development more globally.

While a great deal more research is needed into music-related forms of synaesthesia, my research fulfils an important initial role of uncovering and recounting the unique lived-world experiences of musician-synaesthetes, and may have implications on how musicianship is taught to student-synaesthetes. Indeed, understanding the unique strengths and struggles of individuals with synaesthesia enables practical adaptions to be made to the design of educational approaches. Defining musical development and learning in terms of neurological and psychological processes enables music curriculums to be adapted to the perceptual experiences and needs of students, rather than futilely trying to adapt the students to any particular curriculum (for a discussion of neuro-pedagogical practices in music, see Hodges & Gruhn, 2018).

Recounting the lived-world experiences of musician-synaesthetes has also broadened our collective understanding of the effects of synaesthesia on musical development, and of the complex relationship that exists between synaesthesia and musical potential and ability.

Because of this, we are able to expand our conceptions of musical ability to encompass atypical forms of processing, such as the multisensory processing found to occur in synaesthesia. Synaesthesia research remains a relatively new and rapidly growing field of interest for both musicologists and psychologists, among others, and the richness of the experiences shared by musician-synaesthetes substantially improves our insights into how this condition impacts musical development.

Can absolute pitch be considered a form of cognitive music-related synaesthesia? Can these atypical forms of processing interact in any way?

Synaesthesia and AP are two uncommon cognitive conditions that reflect increased neuronal connectivity and have been anecdotally reported to occur together in individuals. What both conditions require are involuntary and stable mappings between perceptual and verbal representations. If we systematically compare the phenomenological features of both conditions and their relation to different etiological models, what is revealed is that the two conditions share more similarities than differences. This is in contrast to how these conditions are commonly represented in the literature. Indeed, the self-reports of AP possessors commonly match the diagnostic criteria for various forms of music-induced synaesthesia, and by applying the diagnostic criteria of synaesthesia to the AP process, the necessity for an updated definition of AP to be formulated becomes quickly evident. Data collected during my research (Glasser, 2018) endorses the possibility of an integrated, singular phenomenon; furthermore, it also suggests that it might be possible to categorically differentiate AP into *several* idiosyncratic types of synaesthesia.

When these two conditions co-occur in an individual, they frequently interact. Synaesthetes with AP often describe how both conditions support each other in music-related tasks: for example, a musician with musical note-colour synaesthesia may complete a musical dictation task by reading the notes off the coloured image they see. This would be described as an AP strategy, as a typical musical dictation strategy employed by musicians without AP would be to use relative pitch.

Judging by your reasoning and explication, you do not think that synaesthesia is all about having advantages and benefits. What most common impediments would you point out in relation to possessing synaesthesia in general and music-related types in particular?

Musical tasks can be either aided or hindered by synaesthetic experiences; when tasks are hindered, this can lead the musician-synaesthete to avoid certain behaviours or situations. These tasks can be divided into four categories: tasks where the synesthetic percepts create a *mismatch* with the external stimuli, tasks where the synaesthetic percepts are perceived as being *restrictive*, tasks where synaesthetes suggest they are *reliant* on their synaesthetic percepts, and tasks where their synaesthetic percepts are *distracting*.

An example of a task that would fall under the mismatch category would be a musical transposition task, where there may be a contradiction between a synaesthete's association with the original tonality of a musical piece, and the transposed tonality. This transposition could potentially change the colours associated with the piece, and therefore make performing the piece challenging, or even impossible.

The restrictive category refers to the limiting nature of synaesthesia on various aspects of the possessor's musical abilities. Indeed, while the desire to engage with satisfying synaesthetic percepts can influence a synaesthetes music listening or compositional choices, so too can the desire to avoid certain induced percepts. A synaesthete may be aware of the musical merits of a composition, yet cannot overcome the synaesthetic 'dissonance' that arises from compositional aspects of the piece, and thus avoids music by a specific composer due to the ensuing synaesthetic percepts. This is particularly salient in discussions with synaesthetes regarding their compositional choices. Often, the compositional process for musician-synaesthetes will focus on the synaesthetic element, rather than on the musical merits of the composition; from a compositional standpoint there may be a more effective means of composing, but synaesthetes nevertheless indicate they are often led by their synaesthesia to focus on the colours (or other

percepts) engendered by specific chordal progressions and tonalities. This clearly denotes a compelling internal drive beyond the control of synaesthetes, and one they cannot easily override if or when desired. In this sense, synaesthetic percepts can be observed as being potentially limiting in certain compositional situations. Another example of the potentially restrictive nature of synaesthetic percepts is the induction of percepts by the timbral qualities of musical instruments. These percepts can potentially influence a synaesthete's preference or choice of instrument, with synaesthetes choosing to not play or engage with instruments that induce particularly unpleasant colours. A preference or aversion to a particular instrument can also influence several aspects of a synaesthete's musical decision-making, including choice of group instrumentation or involvement, listening preferences, and musical style preferences.

Musician-synaesthetes can feel reliant on their percepts, such as when interpreting music. In these situations, the reliance on these percepts can been seen as inhibiting, as interpretative decisions may be based more strongly on the engendered colours than on the stylistic appropriateness of the music. Music that is in a tonality that induces a pale blue colour, for example, may be interpreted by a musician-synaesthete in a soft or delicate manner, even if stylistically the piece requires a heavy touch. Interpretational options are thus restricted or compressed.

Finally, synaesthetic percepts can be distracting. As synaesthetic percepts typically only cease once the inducer (in this case music) is eliminated, and due to the automatic nature of a synaesthete's percepts (which are unable to be supressed at will), these percepts can be distracting in situations where a focus on musical aspects of a piece is needed. This can also be true in non-musical situations; for example, with synaesthetes admitting to being unable to listen to music before going to bed, as to do so would engender percepts that could make going to sleep difficult.

You state that the variability of experiences of music that synaesthetes report reveals the uniqueness of interpretations

of music in a neurotypical population. What particularities of music experience can be discovered through studying synaesthetes' idiosyncrasies? Does it pertain to the inevitable multisensory implications or expand to broader cognitive mechanisms?

One concept that is central to my research is that our perception of music has less to do with the sound waves streaming in through our ears, and more to do with how that information is processed in our brains and our unique interpretations of that information. Our brains take in information through all our senses, find patterns, and use them to build our individual multisensory realities. What is more, our senses depend on each other and compare streams of data that are woven together to form our perception of each individual moment in time. So, what we know is that we are all experiencing unique realities, constructed in our brains. Studying synaesthesia provides us with an exclusive perspective on this, as synesthetes are a rare group of people whose perception is measurably different from the majority. So, what synaesthesia shows us is that even minute changes in brain wiring can lead to qualitatively different realities, which again reminds us that, from person to person, our experience of reality is different.

Examining the multimodal musical experiences of synaesthetes provides us with a unique perspective on music and the human condition. Music information processing is a multifaceted, multidimensional, and multisensory experiential phenomenon, and unpacking the experiences of synaesthetes enhances our understanding of the ways in which we perceive and respond to music, and of the cognitive and affective processes that support musical behaviours and underlie music perception, aesthetics, and emotion. The undeniable power of music to elicit strong emotional responses in listeners is contingent on each individual's unique interpretation of the sounds they are perceiving, and, on a personal note, I hope that other researchers are inspired to further investigate individual psychological processes that shape music cognition and affect, while advancing discussions

of the many varied questions concerning how learning and development interact with psychological and genetic factors to lead to the full range and magnitude of musical experiences.

According to your research and interpretation of the cause-and-affect relations between synaesthesia, on one hand, and, on the other, enhancements in creative music cognition, including visualisation and memory, concept formation and categorization, does synaesthesia help to subsequently enhance these other advancements? Do they develop alongside synaesthesia or induce the synaesthetic effects?

I suggest that the impact of synaesthesia on musical development can be captured in an experiential feedback model. In this model, sensory information (such a pitch or other music-related synaesthetic inducers) is processed by the brain as a perceptual experience, and provides input in both the cognitive and affective domains, which in turn influence behaviour. As an experience, this behaviour provides feedback to the cognitive and affective domains, and thus creates a loop which is continually activated. Because synaesthesia occurs across the lifespan, this feedback loop exerts a lifelong influence. As is commonly known, synaesthetes regularly report that their very first memories of synaesthetic percepts occurred at a young age. Because of the longitudinal impact of synaesthesia and the continuous reinforcement or reiteration of behaviours that are different to those of non-synaesthetes, these behaviours subsequently develop into a behavioural pattern. Over time, this pattern forms a part of a synaesthete's identity and worldview, and can modify it substantially from what could be characterised as 'normal'. The effects of synaesthesia (both enhancements and restrictions) on musical development are therefore visible at cognitive, affective, and behavioural levels.

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Sérgio Basbaum:

> Common sense about synesthetes is that they live in a somehow perpetual psychedelic world, full of colors and rich sensations.

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How do you define synaesthesia?
Is it one phenomenon or several ones?

For me, first of all, it is a word. As any word, it works as an attractor for several processes, discourses and desires that, in one way or another, it puts in motion. Of course, strictly speaking, science, as a formal and heavily institutionalized way of unveiling nature, aims to restrict its semantic scope, because it depends on reductionism to be able to say anything about whatever. However, culturally speaking, things don't work this way: I came through synesthesia while discussing multisensory art, as many did. And this has led many artists and researchers to get interested in the way psychology and contemporary neuroscience are making meaning of the concept of synesthesia, and making use of it; and has also raised interest in the condition — itself multifaceted — it addresses, with all the consequences the debate on synesthesia has on topics like perception, consciousness, experience, language, aesthetics, etc. Once involved with this, you start to inquire about the relation between artists and synesthetes, about synesthete artists, synesthesia in arts, etc. But then, this also helped shed new light on hard science debates! That's what interdisciplinarity is about: it brings to light these many aspects of the questions we get involved with, for us to build a broader picture of an object.

Meanwhile, research developed, and it also became clear that synesthetic experiences can also be understood as the very condition of our multimodal bodies taken as unified wholes, something Maurice Merleau-Ponty suggested decades before the contemporary boom of the concept. So, in my work, it's been mainly a cognitive condition and a predicate to several works of art which could not fit traditional artistic fields; and, in my effort to understand both, it also emerged as a condition for cognition and also a cultural condition — since Modernity separated and specialized the senses both in discourses (science) and experience (art). Of course, you have (strong) synesthete artists using conventional art forms, such as painting or music, and (weak) synesthete artists doing synesthetic,

multimodal works. An interesting aspect of this is that it corroborates the idea that both are dealing with the same kind of experience. So, if it is a matter of summarizing, I'd say it's an experience. It doesn't matter that much to me if it is biologically elicited (that is, an internally generated phenomenon), or an externally formalized multimodal experience (as in art works); they are sides of the same coin, and thus I subscribe to Lawrence E. Marks' axis of "strong" and "weak" synesthesia.

To what extent is synaesthesia inborn (genetically determined)? What are the causal influences of learning and cognition in its occurrence?

I'm not a neuroscientist, but most of them say so. However, we know today that genes depend on cultural and environmental interaction to manifest a phenotypical aspect, and this is the process named epigenesis; also, there are so many reports of people experiencing synesthesia under hypnosis or under drugs, or even during epileptic seizures, that we have to consider that everyone is a possible synesthete. Cultural elements can be, I think, relevant in several aspects, since perception is culturally modulated, and several authors have emphasized cultural practices that rely on different sensory models that are the basis of a cultural way of making sense of life. Among those models, some assign primacy to vision, some to hearing, some are more tactile… and there are cultures that rely on synesthetic relations to make meaning of their world. Howes (2003) makes it very clear that "Sensation is not just a matter of physiological response and personal experience. It is the most fundamental domain of cultural expression, the medium through which all the values and practices of society are enacted" (Howe, 2003, p. xi). Thus, cultural practices can foster the awareness of inborn relations between sensory modalities they rely on. I have written two articles trying to examine possible relations between cultural experience and synesthesia. In one of them, I have tried to show how disciplinary cultural practices in Western culture have fostered a specialization and separation of the senses (see, for example, Crary, 1990), and how contemporary

digital culture, with its over-stimulation of our sensory apparatus, have made synesthesia a relevant concept in the interpretation of our contemporary cultural experience. In the other, I have tried to compare the experience we live in digital culture with the experience of living in Middle Ages oral cultures, which Marshall McLuhan describes as synesthetic. If I was to speculate about this relation between synesthesia and digital culture, I wouldn't discard that this over-stimulation of the senses (Howes calls it the "hyperesthesia of late capitalism", but I prefer to relate it to digital technology, so I have written about a "technified synesthesia") in digital culture may be somehow related to the increasing emergence of new types of synesthesia we testify. Going a little further, since there seems to be a relation between autism and synesthesia, and there's also a growing incidence of autism forms in contemporary culture, I really think the cultural aspect is as important as the genetic components — although there are many reports of strong synesthesia in families, so it would be stupid the go against this. Nevertheless, since colored-grapheme is arguably the mostly reported form of synesthesia, the question remains: how there could happen such a color-letter synesthete in an illiterate culture? Thus, culture cannot be disconsidered as a minor factor in the broad picture.

In what ways is synaesthesia an advantageous, an impeding and a neutral condition?

I think this question can be better answered by strong-synesthetes. I consider myself a kind of weak synesthete: my vowels have colors, but I don't experience them as vision in peri-personal space. And I've had some color-hearing experiences under the effect of marijuana when I was younger. However, I suspect that it all depends on the way an individual makes sense of his way of perceiving the world: we all have different idiosyncrasies. If you are very sensitive about hearing, and you can't be a musician or make something in your life in which this becomes a way of coupling to your environment, it can be very unpleasing. A classic quote by Luria about Shereshevsky is that he saw so many colors in Sergei Eisenstein's voice that he couldn't follow what

he was saying: sensation would superimpose over conceptual thinking. Several synesthetes report similar experiences. On the other hand, Shereshevsky also could take advantage of his synesthesia in his memory demonstrations, and Richard Feynman used it to organize complex mathematical thinking. So, the way I see it, it's all about the way one makes meaning of life and finds ways of coupling to the world, being who one is. Of course, if one lives in a society that treats synesthesia as a pathology, things get more difficult. So, it also depends on the society one grows into: in certain societies, it may even be better to be stupid; we'll probably be happier! It's all about self-knowledge: understanding who you are, the world you experience, the potentialities you have. As I said, depending on the society, it may get harder.

Are people with synaesthesia special in any other way? Do all people have synaesthesia to some extent?

Everybody is a synesthete in a certain way. We wouldn't understand expressions like "sweet voice", or "loud color", and many other synesthetic metaphors, if we weren't all synesthetes up to a certain level. I think everybody is special in one way or another, but synesthetes seem to have a rich sensorial life, for which many non-synesthetes seem to wish. Common sense about synesthetes is that they live in a somehow perpetual psychedelic world, full of colors and rich sensations. However, everybody is special, and, if synesthetic experience may lead people to experience our shared world in different ways, this is very important, since it means that they help us to build a richer intersubjective world, as much as it places a challenge for them about what can be done with this.

What is your story (and impression) of reading Alexander Luria's *The Mind of a Mnemonist*?

I read the book many years ago. My strongest memory about it has to do with the singular way he experienced life, and how such singularity had taken him to unusual ways of making his living. Because I studied cinema, the passages in which he talks about Sergei Eisenstein brought much attention. I have quoted it several times.

Why is it important to do research into synaesthesia? What are its promises for cognitive science or science at large?

Certainly, synesthesia helps us address several topics on cognition. First of all, there's the singularity of experience. None of us experience an objective reality, which should be the same for all of us: we live in an intersubjective agreement, and the more we admit such plurality of experience, the richer the world in which we live. As Merleau-Ponty once said, "the world is an endless source of meaning". Secondly, by giving raise to such idiosyncratic, often ineffable experiences, I think synesthesia also sheds light on the active, creative aspect of perception: perception is not about a passive reception of an objective world, a "world-receiving", but the creation of a personal world, a "world-making". Synesthesia makes this much more clear. And then there's the question of consciousness, which is considered one of the most important topics in contemporary science, and for which synesthesia opens very interesting windows to get into. I've also always been interested in the relations among digital culture and synesthesia, as I said above, so this seems to me also an interesting and relevant topic of research.

Regarding your understanding of the influence of culture on the sensorium and culture-related specifications of the synaesthetic models, do you think that synaesthetes are people with novel, advanced capabilities or those who retained this phenomenon throughout the course of evolutionary changes?

Evolutionary changes are credited to adaptations and competitive advantages in a changing environment. They happen by chance, but last because they survive best. This is a tough simplification of Darwinian concepts. On the one hand, following the set of ideas I've been supporting, only time will tell us if synesthetes are people with evolutionary adaptive advantages in terms of human couplings in a very intense changing of the media-ecology (I'm using here McLuhan's conceptualization of human technological environment as "media ecology"). Speculating a little further, one way of answering "yes" to this question would be to consider that synesthetic experience is a radical vindication, by the body, of the importance of direct

sensorial experience. Rationalized experience, as we know, banned all kinds of varieties of sensory experience, in its search for an average perceiver, established as "norm", as opposed to other kinds of experiences, regarded as "pathologies", or "diseases". And, as I suggested, Modernity has promoted a radical repression of our sensory unity, over-emphasizing vision above all other senses, and a radical specialization of sensory experience in different art-practices (it suffices to have a look at classical accounts of Modern Painting, by Clement Greenberg, or XXth century music, by Pierre Schaeffer and others, to see how much painting has become a territory "for your eyes only", as much as music became "for your ears only"). The way the body has reclaimed its unity in post-modern art is a good testimony of how artificial the Modern visual-hypertrophy bias has been, and it may be considered that the many forms of synesthesia emerge now as possibilities of multisensory gestalts that, indeed, may be advantageous to calibrate our bodies to an environment of increasing multisensory stimuli. Also, it is advantageous for the culture as a whole, in terms that plurality of ways of perceiving imply plurality of ways of making sense, thus such richness of meaning may help us find some answers for the big challenges to come. The more ways we have of approaching reality, the more chances we have of finding some new answers.

Maurice Merleau-Ponty characterized Time as an ontologically independent entity, not as a construct revealed by consciousness. ("It is indeed the past that adheres to the present and not the consciousness of the past that adheres to the consciousness of the present" (The Visible and the Invisible)). In this context, as the cause of synaesthetic couplings cannot be reflected by congenital synaesthetes and thus their motivations seem unknown, do you think that synaesthesia is a construct? How can we thus reconcile the fact that synaesthesia is a construct and, on the other hand, impenetrable to synaesthetes' consciousness?

First, I don't think this is the correct interpretation of Merleau-Ponty's approach of time. In Merleau-Ponty's phenomenology, time

is absolutely related to the existential experience of the subject, and cannot be severed from it. It is the subject's experience that is time, as the project that develops in a tension between what is not anymore, but keeps present, and what is not yet, but gives sense to the subjects performing in the world: "(…) Thus, time is neither a real process nor an actual succession that I could limit myself simply to recording. It is born of my relation with things" (Phenomenology of Perception). Following Martin Heidegger, for Merleau-Ponty, time is Being in itself; it cannot be thought of in the terms of modern science, for which time is an autonomous variable. In another passage, he says: "We mark out the phases or stages of our life, we consider, for example, everything that has a meaningful relation with our present worries as belonging to our present; and thus we implicitly recognize that time and sense are one.". In the same direction, that synesthesia may be thought of as "a construct" makes no sense: to be a synesthete is a way of existing, and to refuse this in the name of some kind of "average normality" is to deny oneself, so it is painful. Synesthesia cannot be considered as a phenomenon independent of the person who experiences it, and whose way of making sense of existence, and coupling to the world, happens this way. We try to isolate those things because scientific thinking cannot proceed in any other way but by being reductionistic. For me, although not easy, it has always been a matter of understanding how the synesthetic experience situates the synesthete in a different way, how does she or he makes sense of the world, and how this may enrich the intersubjective creating of a shared world.

If you could, please elaborate on the topic of "technified synesthesia". Specifically, how does it change the culture-based models of cross-modal correspondences? As children are getting more and more exposed to digitalized environments, how can this influence those with congenital (strong) synaesthesia?

Technified synesthesia means that we have lived before in a cultural sensory experience which presupposed a unity of the senses,

dominated by an orality which was an expression of the whole body; while Modernity severed the senses and generated ultra-specialized experiences, under a primacy of the eye. The body made its revenge in Post-Modernity; it re-emerged in its unity, in Philosophy and in the arts, in Psychedelic culture, etc. However, all this return happened while a deep technological change was taking place, and this technology, which is now ubiquitous and defines our contemporary societies in many levels, presupposes the submission of any phenomena to the demands of algorithmic calculus. On one side, this technology is creating a world of extreme sensory stimulation; on the other, all these infosensations are based in a mathematization of every object that emerges in the computer-mediated experience. Everything one perceives through any kind of digital interface has been previously calculated. Thus, we perceive the world as a set of precise objects and project this precision over the world we experience. We train our perception to be precise. In what it relates to congenital synesthetes, I'd risk saying they will be more and more refined in their appropriation of their experience.

If sensoria (models of cross-modal correspondences) change throughout history and seem geographically and culturally modifiable, too, do different sensoria generate irreconcilably different ways of meaning-making? What is special about modern western culture in terms of the interrelation of the senses and related meaning-making? (How) can we answer the question of what it is like to be a synaesthete?

Well, as Merleau-Ponty says somewhere, somehow, we read Plato nowadays and seem to understand him. But… this is the so-called birth of Western thought, so it is almost frightening, in a certain sense, the way our present talk is still quite similar to Plato's dialogues, in many aspects. I mean, the way of "telling" the world; the way we speak the world. Concerning this Western conversation, which we name "knowledge building", Heidegger, in a fascinating well-known text, "A dialogue on language — between a Japanese and an Inquirer", gives an extraordinary example of this distinction between Western and

Eastern ways of saying the world. Running a high risk of over-simplifying a super-complex issue, I'd say that Eastern languages seem to retain a relationship to the experience from where it emerges, while Western thinking aspires to an autonomous world of representations, from where things can be objectified and controlled. There's a strong bias embedded in Western language, especially scientific language, to avoid contamination by experience, to be a third-person subject untouched by the impurity of the body and of the world. Concerning what is it like to be a synesthete, we should exercise the description of the experience. In the same way that there's a difference between Walter Benjamin describing his hashish experiences — or Aldous Huxley describing his mescaline trips — and a young drug user saying how he or she was "so high". That is: great writers know how to bring to language their experiences. So, we should expect from synesthetes that they tell us great literary or otherwise artistic reports about what it is like to be them. In a certain way, this has been happening already, on several levels. Pat Duffy is a great example. Carol Steen, also. Marcia Smilack. Messiaen left us great descriptions of his experiences with music! But many others are helping us understand the singularities and regularities of their existences, the varieties of human experience, paraphrasing William James.

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Jörg Jewanski

Once upon the time… in Moscow, 1892.
A fictitious roundtable with seven synaesthetes and researchers from different countries.

Jörg Jewanski, Dr. phil., received an Erstes Staatsexamen in Music and Geography from the University of Münster; a Diplom in guitar from the Musikhochschule Münster; and a Dr. phil. in musicology from the Hochschule der Künste, Berlin, with a study about relationships between single tones and single colors (published as *Ist C = Rot?*, in 1999, in German). Since then, his research interests include relationships between music and visual arts, color organs, colorlight music, music and abstract films, film music, synesthesia and music, and history of research on synesthesia (for example, in the *Oxford Handbook of Synesthesia*, 2013). Book publications (all in German) include *Farbe — Licht — Musik: Synästhesie und Farblichtmusik* (2006), *Musik und Bildende Kunst im 20. Jahrhundert. Begegnungen — Berührungen — Beeinflussungen* (2009), *Portrait Gitarre. Kultur — Praxis — Repertoire — Interpreten* (2011) and *Synästhesieforschung am ‚Prometheus' in Kazan', Russland. Eine Bibliographie der 18 Kongressberichte 1967–2015* (2019). Since 1995 he has been a collaborator of the editorial board of the German music encyclopedia *Die Musik in Geschichte und Gegenwart*, for which he also has published c.100 articles. Currently, he is working on the project *The History of Colored Hearing from 1812 until 1988. A Bibliographical Study with Special Emphasis on Timbre-Color-Synesthesia*, through a fellowship from the Lise-Meitner-Programm of the *Austrian Science Fund* (FWF) and in coordination with the Institute of Musicology at the University of Vienna, Austria.

Moderator: Good evening ladies and gentlemen. A warm welcome from me and the participants of our roundtable to our audience live in the City Hall here in Moscow, in summer 1892 (applause). Today, we have another series of *Make history visible.* My name is Jörg Jewanski, I will guide you through the next hour.

Did you ever hear about people who immediately see colors and forms while listening to music? Or people who see letters or numbers as colored when they read them. This phenomenon is not as strange as you might think. It is quite normal inside the common population. It even has a special name.

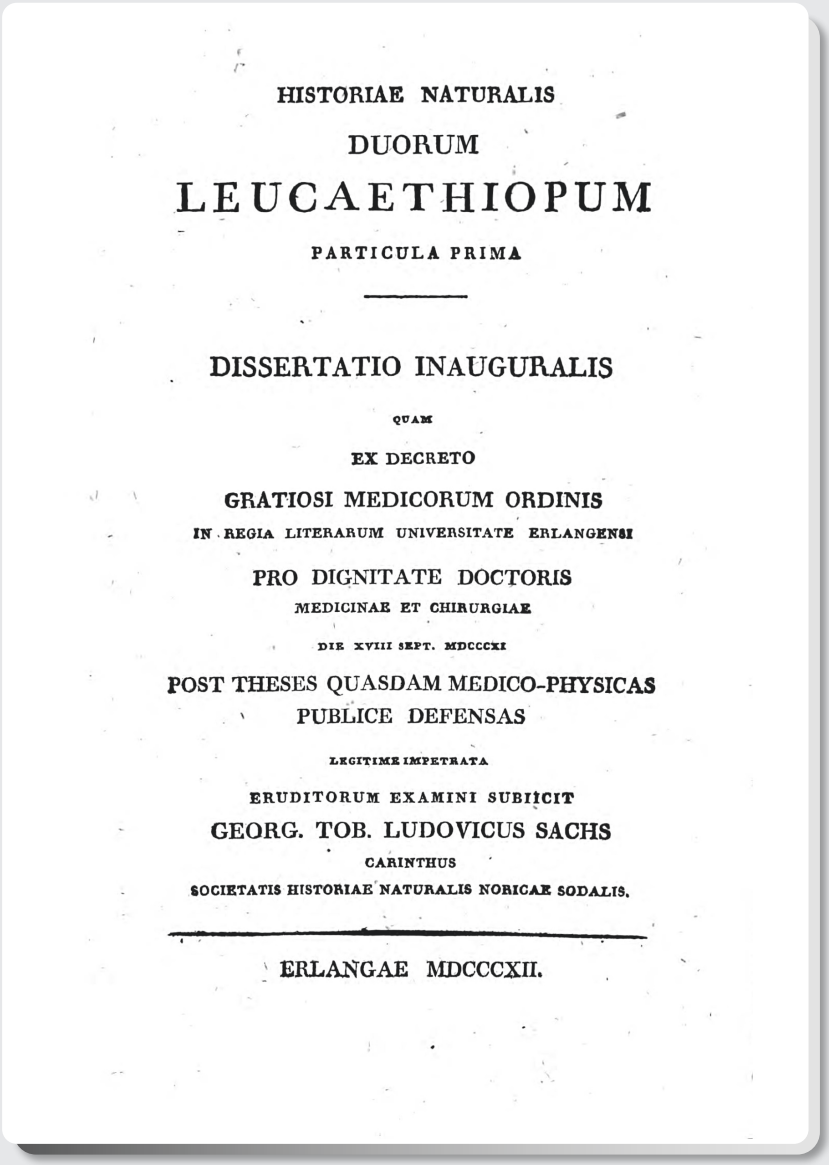
I have invited seven experts to explain and discuss this fascinating phenomenon. Our participants are from different countries and — this is a new model of our show — from different ages! With a special trick, which we do not reveal, we can even invite people who today are already dead. A much simpler problem was the language. We have simultaneous translations via earphones; therefore, we can talk to each other, everyone in his native language.

A last point to mention: Why do we meet just today in 1892? The reason is quite simple. Next year, in 1893, the first Russian article about our topic will be published by the psychologist Vladimir Nikolaevich Ivanovsky.

So, what we will discuss now is the situation 'before' research in synesthesia started in Russia.

Now please give a warm welcome to Georg Tobias Ludwig Sachs from Austria, Édouard Cornaz from Switzerland, Fidelis Alois Nussbaumer from Austria, Francis Galton from the U.K., Eugen Bleuler from Switzerland, and, from France, Ferdinand Suarez de Mendoza and Jules Millet (applause after every name).

My first question goes to Mr. Sachs. You published your medical dissertation in 1812 in Erlangen, Germany, with a study about albinism. As far as we know today, it is the earliest description of someone who sees colors while listening to music. Inside your monograph, there are several paragraphs dealing with something you name *obscure feeling.* Please tell us more about it.



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GEORG. TOB. LUDOVICUS SACHS

CARINTHUS

SOCIETATIS HISTORIAE NATURALIS NORICAE SODALIS.

ERLANGAE MDCCCXII.

The title page of Georg Tobias Ludwig Sachs' (1786–1814) dissertation of 1812

Sachs: As you correctly said, there are only some few paragraphs in my dissertation about it, and I did not draw any connection between my albinism and this obscure feeling. For me, it was a little bit strange to write about it, because I could not find any earlier source to rely on, and as you just said, in 1892, it is the earliest known case description of someone who for example sees colors while listening to music. But a medical dissertation seemed a good place to write about this phenomenon. Well… for me… things which form a simple series—e.g., numbers, the days of the week, the time periods of history and of human life, the letters of the alphabet, intervals of the musical scale, and other such similar things—adopt colors. All these colors are only extremely faint and appear faded.

Moderator: You mean, if you read a word, every letter of the word is attached with a special color? And if you listen to music, each note has a special color?

Sachs: Yes, I describe this also as *dark ideas*. Not all colors occur with these ideas. The brightest—and probably therefore the most frequent—are yellow, white (which, however, is mostly more-or-less gray), pale gray, even also not rarely bluish. The darker (in regards to the ideas) are uncertain: orange, red (almost vermilion), dark gray, bluish, dark green, dark blue. Black occurs once with the letter U; the remaining colors will never be observed, or at least never recognized.

Moderator: And your days of the week are colored?

Sachs: In regards to the week, Sunday is white, sometimes yellowish; Monday grey, Tuesday has a dark and uncertain color; Wednesday yellow, Thursday indefinite green, inclined more to yellowish than bluish, sometimes indefinite and dark orange; Friday dark gray, Saturday is bluish ash-colored.

Moderator: We have another person in our roundtable, who has the ability the see colors, when for other people no colors exist: Mr. Nussbaumer.

Nussbaumer: My brother an I, we see musical notes colored. And we do it since our childhood. When I was five years old, and my brother Johann seven, we played a game using bells and other

objects — such as spoons or forks — that would make a sound, which were all lined up attached along a string. We named the sounds with their colors, and both of us argued when the colors conflicted. Our parents did not understand and laughed at our game.

Moderator: Perhaps it will be easier for all of us if we now give a name to what Sachs names *dark ideas* or *obscure feeling*. Mr. Cornaz, you are the first researcher of our phenomenon, the first to publish a separate article about it with the name of the phenomenon, which you have created, in its title.

Cornaz: This abnormality appears at opposite to me with dyschromatopsia, which is colorblindness; it would be to some extent a hyperesthesia of the 'direction of the colors' and, in 1848, I have given it the name *hyperchromatopsia* (perception of too many colors)…

Bleuler: I am sorry to interrupt, but the phenomenon described by Sachs is not an abnormality! I am aware that physicists during the first half of the 19th century regarded it this way, but in 1881, my colleague Karl Lehmann and I conducted an empirical study and found a ratio of about 13% inside the general population. This is not an abnormality.

Moderator: Okay Mr. Bleuler, we will come back to your study soon. Let's first discuss the name. Mr. Cornaz has named it *hyperchromatopsia* — perception of too many colors. I can add that, in 1864, the French physician Chabalier, who could not attend our round table, gave the condition a new name, because for him it was a disturbance of vision. Therefore, he named it *pseudochromesthesia*, because of the perception of false colors. From 1864 on, Cornaz's term from 1848 was no longer in use. The question as that time was, if the phenomenon was a perception of too many or of false colors. Are there other names?

Nussbaumer: This is totally new for me, because in 1873 I was not aware of precursors. I described our phenomenon as *subjective color sensations*. Another idea was *phonopsia*, which means 'seeing sounds'.

Moderator: Mr. Bleuler, perhaps now you can come back to your empirical study. You did find different kinds of *subjective color sensations*.

Bleuler: Yes, my colleague and I discovered six different kinds of what Mr. Nussbaumer named *subjective color sensations*; five of them

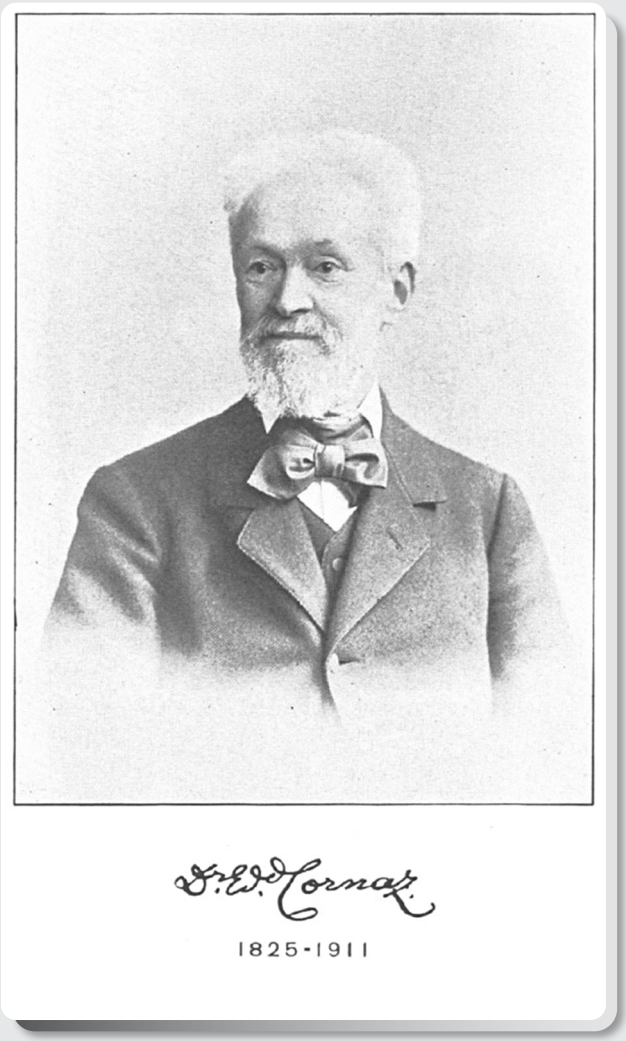
belonged to a stimulus-to-light-sensation and including colors and forms under the umbrella of 'light'; No. 6 was a light-to-sound-sensation. The most frequent one was sound-to-light-sensation. Therefore, we refused Nussbaumer's term *Phonopsia*, because it covered only parts of the issue, as well as *color sensations*, because 'light' is more than only 'color'. Instead, we named the phenomenon *secondary sensations* or *secondary imaginations*, because we were not sure if the phenomenon dealt with sensations or imaginations, although we were more in favor for the first term.

Moderator: Okay, now we have *secondary sensations*. Mr. Suarez de Mendoza, you gave it a new name.

Suarez de Mendoza: Only two years ago, 1890, I published a book about it. As far as I know, it is the most comprehensive monograph about our phenomenon ever written. In France, during the 1880s, what Bleuler named *secondary sensations* was named *audition colorée*, which is in English *coloured hearing*. It goes back to a review of Bleuler's monograph.

Bleuler: Perhaps I can explain it. It is a little bit strange. Our monograph was reviewed several times; one appeared in an Austrian newspaper and was titled in German *Das Farbenhören*, which is *coloured hearing*. The reviewer has named it this way — we did not use this term — because the most frequent kind of secondary sensations was indeed colored hearing. So, the name of one kind of secondary sensations became the name of the whole phenomenon. This review was reprinted and translated, first into English, and then into French.

Suarez de Mendoza: This happened in 1882 by Mr. Louis Pédrono. He translated it in French as *audition colorée*. In 1889, the first international psychological conference took place in Paris with a separate section about audition colorée. This was first time in history our phenomenon got a separate panel inside an international conference. Here the term was established. In my monograph, I went back to Chabalier's term and named it *fausse sensations secondaire* (false secondary sensations) and expanded it to five different kinds — the variety is bigger than Bleuler and Lehmann had suggested — each based



Reproduced from from Tribolet, M. de (1912). Édouard Cornaz. *Bulletin de la Société Neuchâteloise des Sciences Naturelles*, 39, p. 25. Reprinted by permission of the Société Neuchâteloise des Sciences Naturelles, Switzerland

on one sense: *La pseudophotesthésie* (false optic sensations), *La pseudo-acouesthésie* (false aural sensations), *La pseudosphrésesthésie* (false smell sensations), *La pseudogousesthésie* (false taste sensations), and *La pseudo-apsiesthésie* (false tactile sensations).

Moderator: Mr. Millet, I know you were not satisfied with Suarez de Mendoza's terms.

Millet: No, I am not. I read his monograph, but in my just finished medical doctoral thesis, I differentiate between *synesthésie* (for all kinds of combined senses) and *audition colorée* (for colored hearing), because the term *synesthesia* carries its meaning within itself; it is equivalent to the expression *associated sensations*; the term *color hearing* indicates neatly that a color sensation attaches itself to the perception of sounds. Mr. Suarez de Mendoza: I do not believe in having to give currency to your terms, no more to pseudophotesthésia than to pseudosphrésesthésie and to pseudo-apsiesthésie; despite the etymological significance of these words, I don't want to inflict on our readers the torture of having to often spell them. I'll use simpler words, especially to translate complicated things. Therefore, I prefer *synesthésie*.

Moderator: For the rest of our discussion, I suggest to adopt Millet's term, because it is the newest one: synesthesia. What we have learned by Suarez de Mendoza is that there are at least five different kinds of synesthesia, each of them belongs to one sense: optic, aural, smell, taste and tactile. Are there more?

Galton: It is a pity that the main research during the 1880s was done in France without getting to know English articles, especially mine. I am interested in mental imagery: vivid images people see in their mind's eye, for example visualizing numerals. I know a person, who easily and instantly visualizes the figure, if a word such 'fifty-six' is spoken. He does so almost automatically and finds it quite impossible to think of the date of year without remembering and visualizing the figure.

Moderator: Is this synesthesia? I myself, and I guess, everyone in the audience, can visualize spoken numbers as figures.

Galton: Yes, but the person does is almost automatically. This is the difference. But your question is right: Is this synesthesia?

Ferdinand Suarez de Mendoza (1852–1918), reproduced from Carnoy, H. (1903). Suarez de Mendoza. In H. Carnoy (Ed.), *Dictionnaire biographique international des écrivains, des artistes, des membres des sociétés savantes du clergé, du monde diplomatique, politique et administratif* [...] (Vol. 2, pp. 132–141). Paris: Chez l'auteur

In my view, mental imagery encompasses visual memory of scenes, hypnogogic imagery, visual hallucinations, number forms and other associations that would now come under the umbrella of what Mr. Millet has named *synesthesia*. Therefore, I do not provide any terminology for synesthesia, because none is needed: they are simply variants of mental imagery ability.

Moderator: Is this ability learned or inborn?

Galton: With regards to colored letters, Mr. Sachs has reported about this: These forms are survivals of a very early mental stage, and must have originated before the child learned his letters. There is no nursery book or diagram that could suggest their fantastic shapes. Their very variety shows them to be derived from no common origin. I find from inquiries made for me at schools that young people see forms more commonly than adults, but that their forms are less developed and sure. I conclude that, where they are vivid and serviceable, they are much used, and insensibly grow in vividness, in definition and in automatic character. Otherwise, they decay from disuse and become forgotten. Hence arises the rather sharp division between the synesthetes and non-synesthetes, or, as I have named them, seers and non-seers in adult life.

Moderator: Any other theories?

Nussbaumer: My brother and I, we both are synesthetes. This is a too small number of cases to be representative, but I guess it is the first clue in history that synesthesia may be genetically determined.

Bleuler: You are right. I have already mentioned the survey my colleague Karl Lehmann and I conducted. We interrogated a total of 596 people (383 male, 213 female), the biggest compiled group in history up to this date to be examine for synaesthesia, and found 76 cases (45 male, 31 female) to experiencing synaesthesia. We suggested a prevalence of about 13% (i.e., a prevalence of 12% in the male sample and 15% in the female sample). The ratio probably is too high for the whole population, due to our method. I myself am a synesthete and we were asking people inside my family. But this method showed that synesthesia is congenital, because many of my relatives are synesthetes too, and it is not learned during childhood. So, I agree with Mr. Galton.

Galton: A prevalence of 13% seems very high for me. My inquires say 1 in 30 men, 1 in 15 women. This is 3–4% in men, and 5–6% in women.

Moderator: So, the ratio of women to men is 2:1?

Cornaz: At my time, around 1850, synesthesia was known only in men; but the number is too small for us to be able to draw any

conclusions from this. One only has to remember how rare it is to find Daltonism in women. We know that the 'sense of color' is more developed in this sex than among us; but according to this hypothesis, shouldn't hyperchromatopsia be more common among women? It's a reasonable supposition. Therefore, Galton may be right.

Moderator: Mr. Bleuler, you suggested a prevalence of about 13% synesthetes inside the general population. Okay, if your method was not objective, because you asked inside your family of synesthetes: Therefore, let's cut it in half and bring it down to a round figure. We get 6%. This resembles Mr. Galton's results. But: there must be thousands of synesthetes even in Moscow. Why don't we know about them?

Galton: Shyness. Let me tell you a story, if I may, which fits with Mr. Nussbaumer's statement, when his parents laughed at him. At a meeting of the British Association, in which I held a lecture on the subject, at the end of my speech, I asked the assembled to report by raising a hand if they saw similar images. But no one risked it. Then I told a witty story I had read in the Times, and then said: "This is how everyone who sees such number lines in this Assembly has done, so I did not receive an answer to my question; but I cannot drop my subject, therefore I call upon Prof. S., whom I see on the tribune and of which I know that he sees these kinds of pictures, to raise his hand, and then hope that you who have hitherto held back from shyness follow his example!" Thereupon a whole lot raised hands.

Moderator: About how many synesthetes do we know?

Suarez de Mendoza: In the appendix of my monograph, I compiled a list of 134 inducer-to-vision synesthetes, compiled from 36 sources and complemented with eight new cases. These are only synesthetes inside of one special kind. It is the biggest list of synesthetes done until today. But, due to this discussion, I have to realize that I neglected some; for examples, the synesthetes found by Mr. Galton.

Millet: Based on Mr. Suarez de Mendoza's list, I found seven more; therefore, we know of at least 141 documented synesthetes. I have dated my dissertation with March 1892, only some month ago from now. This is the newest state of knowledge.

Moderator: Are people with synaesthesia special in any other way?

Bleuler: One cannot rule out the possibility that double sensations are existent in the predisposition of everyone, but that for the majority of people they are blurred through the remaining experiences of life, respectively, and are not able to come to awareness.

Nussbaumer: My brother, who also is a synesthete, wrote to me that, if he were a painter and musician, then he could make colors exactly for each different tone, and find musical tones for each color, including all possible dissonances; and people would then adjudge that we are gifted by nature to find and present the relationship between light and sound.

Moderator: Relationships between musical tones and colors were done especially during the first half of the 18th century in France, in the surroundings of Louis-Bertrand Castel's color organ. He wanted to paint music and make it visible. Castel was well known through Europe, and in 1742, a small conference took place, the first conference ever about this issue in the context of synesthesia. The place of this conference was in Russia, but not in Moscow—in St. Petersburg. This may be a topic for another roundtable in our series *Make History Visible*. For today, I thank the participants for being here and I thank you, the audience, for listening to us. I hope to see you again next time. Good bye and—good night (applause).

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Anne Patterson:

> When I hear music, I see shape and color…
> My art work is a direct result of my synesthesia.

Anne Patterson is a synaesthete artist from Brooklyn, New York, USA. She holds a Bachelor's degree in Architecture from Yale University and a Master's degree in Set and Costume Design from Slade School of Art, London. Patterson was awarded a Creative Capital Grant from the Warhol Foundation. She is a fellow of the Hermitage Artist's Retreat, and has been a visiting professor at Carnegie Mellon University. Trained as an architect and theater production designer, Patterson creates large-scale multimedia installations that combine sculpture, architecture, lighting, video, music and scent. This unique combination of senses combines to create an artistic practice, hovering somewhere between the theatrical and the experiential. Her large-scale installations have filled cathedrals, office buildings, and galleries across the country with miles of fabric, aluminum ribbon, and metal birds. She created *Graced with Light*, an installation inspired by music, as the 2013 Artist-in-Residence at Grace Cathedral in San Francisco. From the 32 miles of cascading ribbon in *Another Sky* to the 1000 mesh birds in *Murmuration*, she strives to create work that transports us into a multi-sensory realm, similar to that which she has inhabited her entire life. Patterson's theatrical and symphonic partnerships have included major venues across the United States: Lincoln Center, Brooklyn Academy of Music, and others.

Share how you came to know that you have synaesthesia, your earliest memories about it and how much having synaesthesia influenced your understanding of who you are and your creativity. Does synaesthesia play other roles in your life besides art-making and creativity? Are there any other "unusual" thought processes or anything that seems inexplicable in the 'workings' of your mind?

I didn't know I had synaesthesia until a conductor alerted me to the fact. I was creating an installation for Bach's St. John Passion and was talking about the music in visual terms and he told me about synaesthesia. I knew that I always connected visuals with music but didn't know that it was unusual or was considered a condition. My numbers all have genders and personalities. They feel like real people. It has always helped me with math and numbers in general.

What does your synaesthesia tell you about? What can synaesthesia teach others? In other words, what can a synaesthete know about his or her mind, world or art that is not obvious or "open" to non-synaesthetes?

That all senses are connected. What we see also has an auditory component. It makes the world much richer and interconnected.

How would you describe a perfect piece of synaesthetic art, or an absolute experience or lifestyle that feels most comfortable or resonant with your synaesthesia?

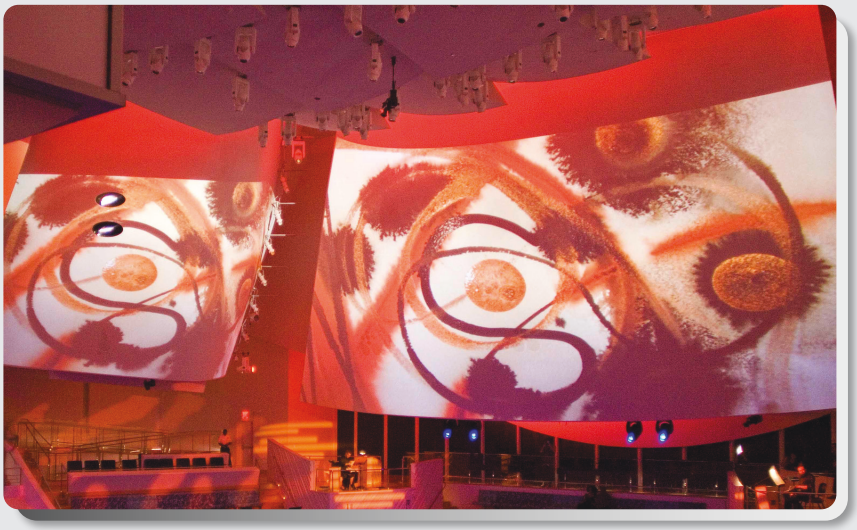
When I go to the opera and see the correct colors on the singers or the correct shapes and colors in the scenery.

What was your first encounter with another synaesthete like? Do you understand other varieties of synaesthesia that you do not have? Which would you like to experience (and why)? What type of synaesthesia would you create if you could? What do you think makes synaesthesia a component of art?

I think it's really hard to imagine the other varieties if you don't have them. I'd love to have taste connected with color. Sometimes some smells do trigger color for me.

Left: Anne Patterson, *Seeing the Voice*.
A panel of falling blue silk in response to cellist Joshua Roman's composition *Riding Light*.
In the photo, Roman is performing at the moment that the blue panel dropped.
Background: Patterson's large-scale installation consisting of hanging ribbons entitled *Graced with Light*. Photo provided by Anne Patterson

Below: Anne Patterson.
Projected images of paintings that were created in response to Mason Bates' music.
Patterson and Bates' performance at New World Symphony in Miami. Photo provided by Anne Patterson



What piece of your art do you consider most influenced by or representative of your synaesthesia? Do you remember how you created it? What other artists not known to have synaesthesia do you feel were nevertheless synaesthetes? Why?

With the set for my first opera, *Barber of Seville*, it was so obvious to me what the colors and shapes had to be. It made it so much fun to design it; made it so easy and playful. Wassily Kandinsky, for sure!

Do you remember any significant life events that may have played roles in developing or reinforcing your synaesthesia? What external factors and conditions are conducive to or hinder your synaesthesia? Have you ever done anything "against" your synaesthesia; for example, suppress it or experience something contrary to your synaesthetic reaction? If yes, what? If no, why?

I think having trouble learning my times tables really helped me develop an awareness of my numbers as personalities.

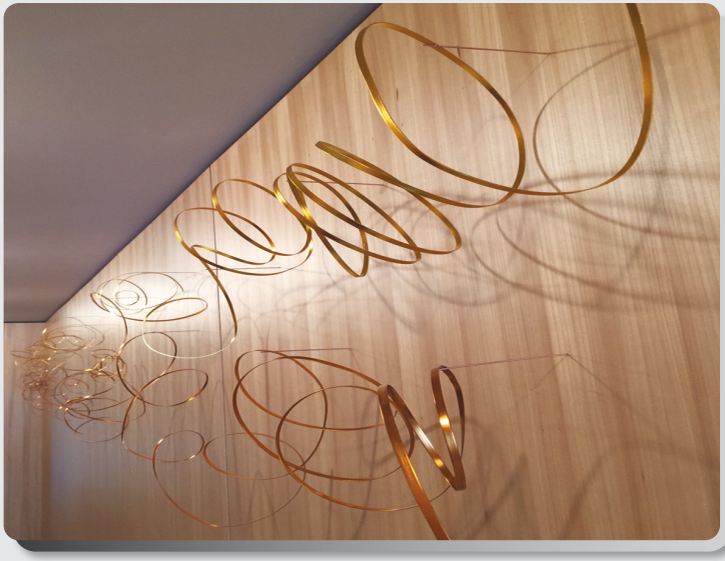
When I broke my dominate right arm and had to draw with my left hand, I connected even more deeply with my synaesthesia.

How do you feel about the way the synaesthesia you express in your creativity is being received by others? Do you think your synaesthesia isolates or connects you to other people? Could you use your synaesthesia more extensively in art-making? Would you, even at the risk of being misunderstood?

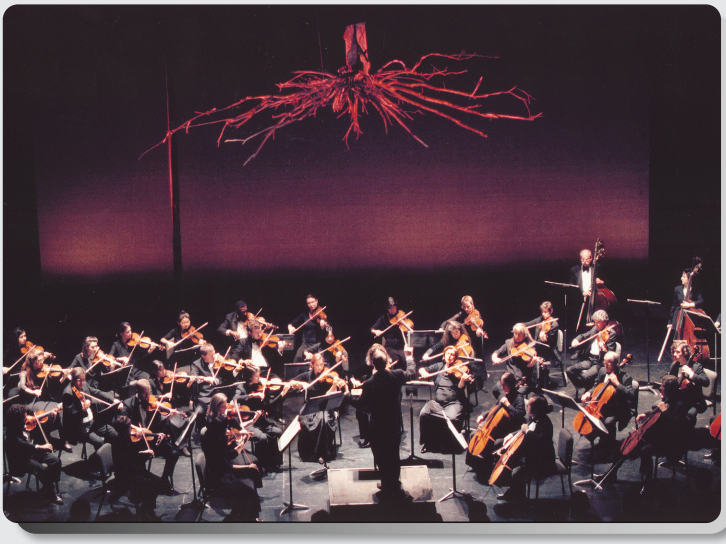
I think people find it fascinating and I think it opens up people's minds to the possibility that they too might have synaesthesia. I think, the more I use synaesthesia in my art-making, the more it will be understood, because I think it makes my art more relatable too, on deeper and more disparate levels.

Your works — lines, color and encompassing space — seem to resonate with the ideas of the Russian artist Wassily Kandinsky, who said that everything starts with a dot. Your synaesthetic creativity — what does that start with?

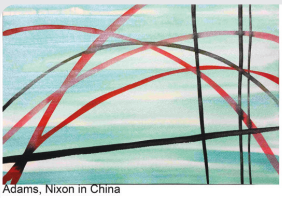
My creations start with music.



Anne Patterson, *Tandem Dancer 2*, 2015. This sculpture was created in response to Claude Debussy's *Afternoon of the Fawn*. Photo provided by Anne Patterson



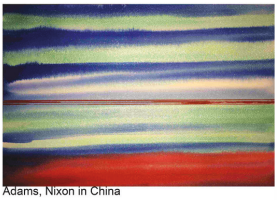
Anne Patterson, *Strings of War*, 1999. "I created this sculpture out of driftwood in response to Dmitri Shostakovich's Op. 110. One of my favorite pieces of music." Photo provided by Anne Patterson


Adams, Nixon in China


Mozart, symphony No.40


Adams, Harmonielehre


Adams, Harmonielehre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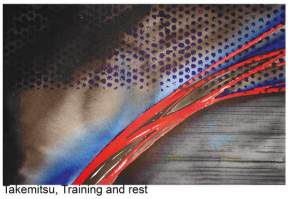
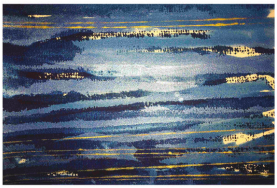
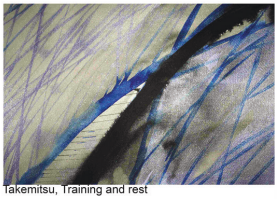

Takemitsu, Training and rest




Prestini, House of solitude


Takemitsu, Training and rest


Mozart, Raquiem


Prokofiev, Romea and Juliet


Takemitsu, Waltz


Reich, Clapping


Bartok, No.2


Stravinsky, Symphony in C

Anne Patterson's series of music inspired paintings.
Pictures created and provided by Anne Patterson

Having a type of synaesthesia that associates your numbers with genders and personalities, do you feel a creative urge to also use it sometime in your art-making? How different is this special type from the types that you intertwine more in your artistic expression?

I don't tend to use numbers in my work in a representative way. Some of my installations have complex patterns and layouts and so sometimes, when I am mapping out projects, I use my perception of numbers to help me conceive of the layout.

Do you think your creative and art-making process would be the same if you did not know you are a synaesthete?

Not at all. My art work is a direct result of my synesthesia. My relationship to music and nature and the images that those experiences trigger are where my creative art-making comes from.

In the Mercury Soul project, in collaboration with composer Mason Bates, you created a series called *Seeing Music*, which is a set of abstract lucidly colored paintings. What was inspiring you while working on this series? How did you work together with Mason Bates? Was it discordant at times?

I was listening to Mason's music to create those sculptures and paintings. I then would show my creations to Mason. There was nothing discordant in Mason's music that I was responding too.

In your theatrical works, you seem to lean towards using a basic, plain and vivid color palette. Why? What is your attitude and techniques in using color? Do you think color is special to your art-making?

I pride myself on my color sense. I manipulate color to influence the viewer's experience of a play, an opera or a symphony. I believe color is very powerful in the way that it can affect our emotions and even our thinking. In a way, it is obvious. I use red to heighten the energy and blue to calm. If it is a piece with music, I let the music guide me. For instance, in one of my earliest opera designs for Gioachino Rossini's *Barber of Seville*, it was blatant to me that the colors of the set

had to be orange, yellow, red and pink. The music seemed to dash around and so I designed set pieces — moveable walls and furniture that could also dash about.

For the *St. Matthew Passion*, I wanted to convey the sense I had of Bach's music encompassing us, so I created a set that enveloped the audience and also the players and singers. It was full of rounded shapes. In contrast, the set for the *St. John Passion*, to typify the linear quality of the music, consisted of straight lines.

Kaitlyn Hova:

> It would be wild to have an entire orchestra performing on synesthesia light projector instruments some day!

Kaitlyn Hova is a professional violinist, neuroscientist, software engineer, UX designer, TEDMED speaker and performer, co-founder of Hova Labs, advisor of Women Who Code, and synesthete. Hova went to at Berklee College of Music for violin performance and then the University of Nebraska at Omaha (UNO) for pre-med. Upon discovering that she has synaesthesia, Hova switched her pre-med major to neuroscience. Professionally, Hova has played violin for performances with Michael Bublé, Trans Siberian Orchestra, Mannheim Steamroller, Mary J. Blige, Josh Groban, Rod Stewart and more. At Hova Labs, she and her husband, Matt Hova, co-created the Hovalin, an open source, 3D printable, acoustic violin, with the goal of assisting underfunded school music programs by reallocating STEM grants to enable schools to 3D print instruments for their orchestras. She performs on Hovalin with custom electronics that uses LED lights to translate her performance into a projection of her musical note-to-colour synesthesia in real time. Additionally, Kaitlyn co-created The Synesthesia Network, a resource dedicated to helping people with synaesthesia share their experiences and connect with researchers. As a public speaker, Kaitlyn is an advocate for syneasthesia and speaks on consciousness, creative solutions for good, her kids, and her cat.

Share how you came to know that you have synaesthesia, your earliest memories about it and how much having synaesthesia influenced your understanding of who you are and your creativity. Does synaesthesia play other roles in your life besides art-making and creativity? Are there any other "unusual" thought processes or anything that seems inexplicable in the 'workings' of your mind?

The first moment I knew that I had synesthesia was when I was in my final music theory class in college. Our professor mentioned that "Some people physically see sounds", which I honestly thought was a something that everyone could do. At that moment, I had flashbacks to several events early in my life where I remember saying things that sounded weird to other people but made total sense to me. I never questioned my synesthetic experiences growing up; but, once I found out that they were called "synesthesia", I became more introspective. Out of that introspection, I began to actively use my synesthesia as a tool to write and perform music. For example, it turns out that I have favorite keys because of the colors they make and I've found that I enjoy specific rhythms and instruments because of the shapes they create. I use synesthesia just like any other sense. For example, with my grapheme-to-color synesthesia, I can search through my computer code to find specific functions pretty quickly. I find that the funny thing about synesthesia is that it all makes sense to me until you vocalize what you're experiencing to someone else.

What does your synaesthesia tell you about? What can synaesthesia teach others? In other words, what can a synaesthete know about his or her mind, world or art that is not obvious or "open" to non-synaesthetes?

I like to think that my synesthesia is a colorful translation for my sense of sound, people, numbers, and letters. The translations make sense to me alone but they are fundamental to how I understand the world around me.

Synesthesia can teach people about how all of our experiences of reality can vary. Those that are aware of their synesthesia are just

more conscious of how they are processing the world around them. Sometimes, how you experience the world can be more interesting than the world itself.

How would you describe a perfect piece of synaesthetic art, or an absolute experience or lifestyle that feels most comfortable or resonant with your synaesthesia?

For me, the most perfect piece of synesthetic art is a good song that uses several different synthesizers and instruments that are thoughtfully "panned" across the mix. Each instrument has a different shape/color to watch and the panning spreads them across my visual field (lower sounds tend to be on the bottom left and higher sounds tend to be on the top right).

What was your first encounter with another synaesthete like? Do you understand other varieties of synaesthesia that you do not have? Which would you like to experience (and why)? What type of synaesthesia would you create if you could? What do you think makes synaesthesia a component of art?

The first other synesthete (that was conscious of their synesthetic experience, at least) was at a synesthesia conference in Nashville. For the first time in my life, I debated "what color is _____" for people, sounds, and letters. I felt heard and it was wonderful. Instant friendship! Having any type of synesthesia opens me up to partially understanding other types of cross-sensory experiences; but, when it comes to synesthesia that I don't have, I am still fascinated and surprised by the "day to day" experience of having it.

Having Mirror Touch synesthesia sounds exciting but also horrible. I would love to be able to sort of read other people's minds by physically feeling what others feel, but I understand that it would be a double-edged sword. Gruesome horror movies would be even more unwatchable than they already are for me.

It would be a real game changer if, every time I exercised, I tasted warm cookies. I enjoy songs that paint a beautiful landscape

with several different tones/textures to explore. It's impossible to say anything art is objectively "good" or "bad", but being able to expand an experience to more senses gives me more opportunities to compare.

What piece of your art do you consider most influenced by or representative of your synaesthesia? Do you remember how you created it? What other artists not known to have synaesthesia do you feel were nevertheless synaesthetes? Why?

Performing my loop pedal violin pieces with my synesthesia light projector violin is absolutely the best representation of my synesthesia to date.

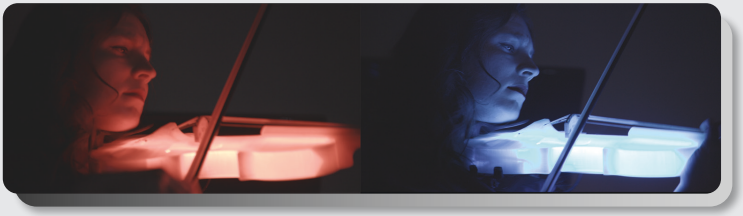
The logic behind creating this was to break down my synesthetic experience into something that others could understand. I always start the pieces off with a simple loop that demonstrates how each note has a specific color and a position in space. As the song gets more complex, the colorful landscape begins to form.

I think that, on some level, the majority of musicians and artists are synesthetic but may not be actively conscious of their synesthesia. This is probably because I can't imagine how anyone could have something like "perfect pitch" without physically seeing sounds.

Do you remember any significant life events that may have played roles in developing or reinforcing your synaesthesia? What external factors and conditions are conducive to or hinder your synaesthesia? Have you ever done anything "against" your synaesthesia; for example, suppress it or experience something contrary to your synaesthetic reaction? If yes, what? If no, why?

Learning piano at an early age may have had a large role in organizing my synesthetic tendencies. For me, notes that fall on the white keys of the piano are more vivid than the black keys, which could be because I spent more time playing them early on in my studies. Additionally, lower notes tend to manifest in the bottom left and higher notes tend to ascend to the top right of my visual field, sort of like a piano.

The Hovalin is listening to the silence in the Small Hall of the Tchaikovsky Conservatory. Photo: Kaitlyn and Matt Hova



Kaitlyn Hova is playing her synaesthetic Hovalin at the Tchaikovsky Conservatory at the IASAS Moscow Synaesthesia Symposium, 2019. Frames from a documentary by Olga Pankratova

Kaitlyn Hova performing at the press-conference on synaesthesia in Moscow, 2019. Photo: Kaitlyn and Matt Hova

I've noticed that eating sugar and a dark backdrop makes my experiences more vivid. One of my favorite things to do is to eat candy then go for a run while listening to music at night.

Sometimes my synesthesia can get in the way of things, but I've found ways around it! In order to focus on my work during the day, I'll wear noise canceling earbuds so that the colors I'm experiencing are only the ones I need to focus on in my work.

How do you feel about the way the synaesthesia you express in your creativity is being received by others? Do you think your synaesthesia isolates or connects you to other people? Could you use your synaesthesia more extensively in art-making? Would you, even at the risk of being misunderstood?

Overall, I've had a positive response to how I've expressed my synesthesia through my synesthesia light show performances. Breaking down the colors into easy to digest loops has been a great way to help others understand my musical notes to color synesthesia. When others can understand the patterns of my synesthesia, they realize that it's not so crazy of an experience after all.

When I didn't know what these experiences were, growing up, I would have said that it was isolating; but, now that I know that these experiences are called synesthesia and how common they potentially are (1:23 people), I would say that they connect me to other people. I'm always looking for more ways to further explore my synesthesia!

How do you feel when you encounter incongruent experiences of other music-color synaesthetes' creativity and performance, i.e. when their color-based and location-specific interpretations of music, for example, are slightly different from yours?

It fascinates me when I encounter incongruent synesthetic experiences because I think they are all beautiful in their own way. The world would be so boring if we all experienced it the same.

Now, when you have fulfilled your dream of producing a fully functioning synaesthesia light projecting violin, do you think of going still further in this direction? What might be your wildest ambition here?

We are always fine tuning the current violin for smoother lighting transitions, but eventually we'd love to expand to supporting more instruments and have the instrument control lighting outside of itself. It would be wild to have an entire orchestra performing on synesthesia light projector instruments some day!

Now, since you have known that you have synaesthesia from very early on, in what way will your upbringing of your own child be different? Are there any ways that you will try to make her aware of your or her own (possible) synaesthesia? Any teachable moments here?

I think it's very common for parents to dismiss seemingly "nonsensical" statements by their child. However, we look forward to being more open to exploring the way she experiences the world. Once she is old enough to talk, we want to ask leading questions (ex: "what color is the letter A?") and tell her in depth about my experiences in order to see if anything registers for her. To us, creating a dialog about how she arrived at her answer is just as important as the answer itself.

Dmitri Matkovsky:

> I cannot say that synesthesia is a part of art; rather, it is another very rare tool for creating a work of art, another device for a person's exploration of the field called art.

Dmitri Matkovsky is a synaesthete artist and musician. He experiences "coloured hearing", perceiving sounds through colour, and calls his work "music on canvas". His first band, *Manufactory*, became a winner at the first Leningrad Rock Festival, after which Dmitri worked as a guitar player for 10 years as a part of a rock band *Auktsyon*. Acquaintance with Gerard Richter drastically changed the vector of Dmitri's life, and, in the 90s, he left for Germany, where he worked as an artist's apprentice. At that time, he started realizing the nature of his own perception of art, the unity of music and colour. Among teachers, he also points out his godfather Alexei Khvostenko and Viktor Proshkin, a watercolor painter from St. Petersburg. Ten years of life in Canada framed him as a professional in the field of fine arts. The artist created a series of "sketches of air", which he later turned into large-scale paintings. These works became the artist's hallmark in Toronto. During that time, more than 40 of Matkovsky's works were purchased by collectors and museums in America, Europe and Japan. Currently, Matkovsky lives in St. Petersburg and keeps painting, doing 3D-animation, design, music, and yoga, as well as journalistic work.

Could you tell us when and how you learned that you have synesthesia? What are your first memories of it, and how much is synesthesia affecting your own awareness and understanding of yourself and your work. Does synesthesia have any other influence on your life besides art and creativity? Is there anything else unusual or obscure that you notice in the way your consciousness operates?

The fact that I "have synesthesia" sounds a little strange to me. I have been experiencing the phenomenon of connecting colors with music from birth; it is a part of me, of what I am, the same as if an ordinary person would show off their eyesight or hearing abilities. Since these sensations always went side-by-side, I never connected them to any specific process or a peculiarity of my body. To this day, the word synesthesia sounds unusual to me, and gives a feeling of something scientific and deeply serious. But I always saw my abilities as a kind of invasion, some sort of external violence against my internal state. Sometimes, I was just afraid of getting associated with some special group of people. Fortunately, my life path is directly connected with art, and in art, being different from others is more an advantage than disadvantage.

The term "synesthesia" itself I learned recently, during my exhibition in St. Petersburg in 2015. We communicated closely with the curator, after which he wrote an introductory article where I was called a synesthete. That got me into exploring the meaning of it, and I started remembering many interesting moments that should have led me to this term long before. When I was a musician, it did not greatly affect my musical life; but once I became a professional artist, it began to play a significant role in my life and work.

For some unknown reason, I do not have a single memory before 5 years old and that might not seem strange to most people, but I did not remember it even when I was 7 years old! My memories begin at the age of 7, when I was examined to get admitted to a music school. I remember how a woman was playing different intervals on the piano, and I had to say if she played 2 or 3 notes, which one was higher, and which was lower. But I just could not understand what exactly was

Storming of the Bastille, Parisian Surrealism, acryl on paper, 73×51 cm, 2018. Reprinted by permission of the artist

Life Philosophy, acryl on paper, 86×61 cm, 2013. Reprinted by permission of the artist

Saint Isaac's Cathedral in Twirls of Thought or Magnet Storms of Petersburg, acryl on paper, 150×136 cm, 2017. Reprinted by permission of the artist

expected from me, because I saw everything in color. I had not seen a single musical instrument before that. Sounds, to me, were noises pouring from a small box plugged into an outlet. But, for 2 years, I had been going to an art school and had been painting constantly; so, at the exam, everyone just could not understand what I was trying to say. As a result, I did not get admitted into a music school, and was offered to practice on drums, but the way it was said was almost offensive. Over time, in order to prove to everyone that I have an ear for music—and, as later it turned out, absolute pitch—I have been playing music professionally for 25 years.

Speaking of an influence of synesthesia on me, one needs to understand my view on art. Art is an immersion in oneself, when people are so immersed into themselves that they can express the internal processes, phenomena and experiences by means of art, and it happens in such a strong and emphasized way that it affects everything one does. Of course, any emotions are greatly complicated due to their combination and intersection with each other, and therefore great difficulties can occur even in perception of fairly simple objects and situations. The perception of life through two different senses sometimes causes a panic state of mind, makes it weaken the grip, and individuals get a rare opportunity to express the essence of what they feel, rather than mental clichés. The less the influence of mind on the creator of a work of art, the closer it is to Real Art.

Of course, mastery should never be discounted; but, as a rule, mastery gets in the way more than it helps. Our knowledge definitely suppresses the freedom of creativity. That is, if people lack mastery, they will not be able to fully express whatever is overfilling them from the inside. But, if they have a lot of skill, they will rush to do it right, but not the way their hearts see it. Synesthesia undoubtedly affects my life because it makes my perception deeper, and life itself more subtle. Imagine if you perceive something with not just one, but several senses at the same time. This is best understood if you compare a two-dimensional image with a three-dimensional one or imagine watching a movie with and without sound. It does not just

increase the fullness of life, it adds another dimension to the world, makes it four-dimensional.

What is the meaning of synesthesia for you? What can synesthesia teach others? In other words, what is it that synesthetes may know about their inner world, surrounding or creative one, which may not be obvious, or even "hidden", from non-synesthetes?

It is obvious to me that all forms of art are like different facets of one whole. We can look at it from one side or the other; the process, the very creation of a work of art, is important. The process of creating Art is very similar to life itself. Love and honesty outweigh everything: skills, money, you name it... Synesthesia helped me understand that any person can make art. Just like any gifted artist can move away from it, to start doing something good and interesting, but without any spark of inspiration, which, for me, is the main difference between a work of art and just a well-made thing.

But then the question arises, why cannot all the people make art? The answer is very simple. most believe that, in order to make a work of art, you need to have a great talent and skill. But, in fact, it is not so. God made everyone in his own image and likeness, and therefore the ability to create is an integral part of a person. You just need to believe in yourself and do something sincerely and you will discover a Revelation, the beauty of your own soul, that you immediately want to share with others. So do not hold yourself back!

But the two most difficult things in the world are to believe in yourself and to not be guided by the mind when making art. It is also very important to start your way of creating in the area where you have the most abilities. We are taught at school to discover the world by copying; but, for creativity, this is a dead end. We are born with different abilities, and people themselves cannot always understand it, but that is what we need teachers for. It sounds corny, but I spent 5 years trying to draw what I like or want, instead of drawing something the way I can and do better than anyone else.

How would you describe the ideal work of "synesthetic" art, or an event from life experience that perfectly matches and harmonizes with your synesthesia?

More than 100 years have passed since the great synesthete Scriabin tried to combine music and colors. Now there comes a time when, using artificial intelligence, it can be done much easier. I think that the most striking event in my life connected to synesthesia is the project that I prepared for the Mariinsky Theater. Synesthesia was the very foundation of this project; it was drawing live, during the performance of a symphony orchestra. My painting was supposed to arise during the concert and be broadcast on many monitors and lighting devices. Unfortunately, the project got suspended due to the lack of funding.

What was your first acquaintance with other synesthetes? Do you understand other types of synesthesia that you do not have? Which one would you like to feel (and why)? If you could, what synesthesia would you like to create? What, in your opinion, makes synesthesia a part of art?

My first acquaintance with synesthetes happened very early. When I was 12 years old, my mother took me to Scriabin's concert *Prometheus*, the sound and light symphony of the great composer of the 20th century. It made a huge impression on me.

I recently learned that there is synesthesia called grapheme-color; that is, when numbers are perceived in certain colors. In my youth, I was engaged in mathematics and programming, and it would probably be very interesting for me to feel the numbers in color mode, especially now when I have become an artist.

What would I like to create? Perhaps, due to the fact that the strongest impression of my childhood is Scriabin's symphony, or because I am also a synesthete artist, and because I am a musician (that is for life), the most interesting thing for me would be to create a symphony of light and music. I have actually been moving towards this for quite some time; for 2 years, I have been working on creating lighting effects and 3D animations for stage artists, which gave me experience and

self-confidence. I cannot say that synesthesia is a part of art; rather, it is another very rare tool for creating a work of art, another device for person's exploration of the field called art.

Which of your works do you consider to be the most synesthetically "saturated" and indicative of your synesthesia? Do you have any memories of how you created it? Do you "suspect" synesthesia in any of the creative people, where it is unknown whether they have synesthesia or not? Why?

I believe that I have not yet fully created a single truly synesthetic work, because it is difficult for me to say what a non-synesthetic work is. For me, everything I do is filled with synesthesia. It is always a 100% synesthetic work of art. But my works may not reflect the process that takes place in my mind during their creation; this may be invisible, or may only be visible to me, or only to synesthetes. I cannot know how women perceive my art, because I am a man. Perhaps any person can feel the unity that I feel inside of me, the unity of music and color, but I cannot check it. Speaking of my musical works, which cause my strongest visual and color associations, these would undoubtedly be the songs "Ears" and "My Love", recorded by the group Auktsyon. BBC named "My Love" one of the 20 best works of 2001 in the world, but I do not know how much you can feel the saturation of this work with synesthesia.

I still have a memory of how I created "Ears", because, since then, I have been constantly using this method for my visual works. I would call it a layering method, creation of large planes. When I was writing this music, these were musical planes; now these are visual planes. First, I create these visual planes, and then I erase the unnecessary in these planes; that is, I act as a sculptor. First, I create layer by layer the material from which I will then etch out the places I do not need, and, in the end, exactly what I need gets left—a painting or a musical canvas.

I do not suspect synesthesia in any creative people. But I think that all creative people have a certain connection between the perceptional senses, but not everyone knows about the existence of such a thing as synesthesia, as I myself did not know about it until recently, and

I am already 57. That is, any creator works at the level of reflex, at the level of sensations, and it is very difficult to describe in words what you are doing. Therefore, I am almost sure that most creative people, especially prominent artists, are to some extent synesthetes. The only person who, as I previously supposed, was an alien, and now I know is a synesthete, is Jimi Hendrix. His music, which for aesthetic reasons I do not like, causes a storm of emotions in me, a visual flurry; I literally fall into euphoria, a coma or I don't know what, because, in this state, it is impossible to even evaluate what you feel.

Among the creative people with synesthesia, the ones who made the strongest impression on me were Jean Sibelius and Vladimir Nabokov. I did not know the reason yet, but I just could not read Nabokov; it was causing hundreds of visual emotions. There were so many of them that I could not get the meaning of what I was reading. The same situation was with the music of Sibelius. In my early childhood, 7–8 years old, I could hardly hear anything; I was only seeing what my mother and sister were listening to. After that, I was trying not to listen to Sibelius anymore. And, for example, I perceive Mozart's music as pretty ordinary, with no "special effects". Up until this day, I do not read Nabokov and do not listen to Sibelius. It is like hard drugs for me.

Have you had any important life events that influenced the appearance and development of your synesthesia? What external factors and conditions contribute to, or, conversely, suppress your synesthetic sensations? Have you tried to do anything "against" your synesthetic reactions; for example, suppressed their manifestation or tried to react contrary to them?

Undoubtedly, the concert performance of the Prometheus symphony in the best hall of Leningrad in the seventies influenced my development of synesthesia. But Nabokov and Sibelius reinforced that feeling. And dreams. The fact is that dreams play a very important role in the way my consciousness works. In fact, everything is created in a dream, and for the whole next day, I am trying to combine these

disparate pieces of sleep, like a puzzle, into an overall picture of what I saw. My dreams are not just colored or black and white, realistic or abstract paintings. They are not even stories, because for me they are not dreams, they are my life. I am not able to distinguish my dreams from reality. The journey of finding it out and understanding it is a long and curious story. For a long time, I thought that I do not remember dreams, that I have no dreams. But once, I woke up feeling the need to call one person, so I took the phone book and found the number. And, at that moment, I realized that this person died 5 years ago. Then I asked myself, if you remembered he died, then why were you trying to call him? And then I realized it was in a dream. I realized that dreams are an integral part of my life, that it is dreams that feed this feeling of mine called synesthesia.

My senses are greatly influenced by sound. So, any annoying sounds, any sounds not related to my creative process, extremely weaken synesthesia: they decrease my concentration at first, and then it disappears completely. The darkness of the night, calmness of the rain — these sounds enhance synesthesia; but any noises, unpleasant sounds, for example, TV or radio, playing in the background, even if barely audible, weaken my esthetic sensations.

Yes, I often go against my synesthetic reactions. Why? Because it is some kind of way to find something out of the box. Although, at the editing stage, I often get back to the path of beauty and harmony, and correct the traces of struggle with my natural synesthetic reactions, it brings me to a state where I can discover something very unexpected, and it definitely is worth it, to deceive myself!

How do you think synesthesia expressed in your work is perceived by others? Do you think that synesthesia alienates you from others, or, to the opposite, helps you interact with them? Do you have an opportunity or desire to use synesthesia even more intensely in your work? Would you continue, despite of the risk of being misunderstood?

I do not believe that synesthesia distances me from others. Firstly, no one knows about my synesthesia; or, when someone listens to my

music or observes my paintings, they do not think about it. People either enjoy what we call a synesthesia product or not. They feel the harmony and beauty that appears in my paintings because I harmoniously experience them at the sound level. The audience is interested in the end result, not in how I saw whatever finally became a work of art. Ultimately, the fact that I draw abstractions and hear music, which is the most abstract form of art, helps me a lot in the process of creation. But, in ordinary life, synesthesia may be more of an obstruction for me; for example, in communication, as I hear and see many things too differently, and sometimes this causes a lot of misunderstanding. For example, many words or questions that have answers obvious to everyone seem completely unclear to me. They are multifaceted, multifunctional, and therefore incorrect; that is, they do not have one answer or one interpretation. Then I have to turn off my synesthesia for a while, with great efforts of will and mind. But, in fact, I do not have this skill; rather, it is a trial and error method that requires a lot of strength, which is very distracting. Therefore, in ordinary life, there is no time for it, and people find me weird.

Of course, I have a desire to use synesthesia in my work more broadly. But it is a feeling that develops very slowly, and according to its own laws that are incomprehensible to me, so all I can do is to cherish this feeling and use it as often as possible at the risk of being misunderstood. Every artist is in danger, especially if he or she feels differently than 99% of the population. But it is an important and necessary component in art, so I am not upset about this. It is what it is.

Do your color reactions to music have any unchanging patterns? How does your absolute pitch manifest in this? How exactly do you perceive the color of music: in which space (where exactly) or in what forms (stripes, circles, etc.)?

I never tried to classify my emotions, no matter what they were about, and I did not try to draw any parallels between sound and color, let alone remember them. Why? This is not a matter of laziness

or carelessness. The fact is that any knowledge reduces our freedom of thought and creativity; so, for me, it is a way (not to establish these connections) not to formalize, not to form new patterns, or stamps. Of course, patterns appear from time to time, but I try to destroy them right away, by acting contrary to them. Forgetting them is not an easy thing to do; they need to be replaced by other connections.

I do not think that absolute pitch somehow changes my picture of the world or its accuracy. In any case, it is already too difficult to compare with the situation when I did not have it; it was a very long time ago. I perceive sound and music in the form of layers, sometimes 3D layers, such as clouds, but mostly transparent 2D layers that refract and move in different directions. But sometimes these planes narrow down to lines. And light usually illuminates them either exactly like daylight, or in concentric circles or circumferences.

Please tell us about the relationships between your dreams and synesthesia. What does your experience mean that you describe as "dreams that feed synesthesia"? How does this relate to your creativity, perception of music and understanding of color?

The truth is that I rarely remember my dreams or even the fact that I had them. But sometimes, for various reasons, I understand that I saw something or what approximately it was about. In any case, if I am sure I had it, my synesthetic reactions intensify or take a slightly different, new turn. This is another way for me to ensure the presence of a dream, and that it is time to listen to music and paint. Music or sound greatly deepened my understanding of color; I feel the color more subtly, which sometimes leads to a misunderstanding by people who see or feel colors differently. For example, they see more of yellow or red in orange and do not see green in it, which is formed from the blue shadow of minor harmony E, etc. Let alone music, that I always imagine as a moving picture.

You describe synesthesia, along with your other abilities, as "invasion", even "violence" over the internal state. Does this mean that synesthesia somehow suppresses your creative freedom? If you were to become a mentor for younger synesthete artists, how would you teach them to "use" synesthesia? What could be the peculiarity of being a synesthete artist in the most complete way possible?

A hurricane for sure restricts your freedom, but as it begins to calm down, you can see that everything around you acquired a new, fresh shade or even completely changed appearance. Same with synesthesia. When an attack occurs, I just have to wait out its aggravation, and then rush to reap the benefits, because my feelings intensify and become subtle. Synesthesia is not something invariable and constantly having its own face; it is like odors that elude us from nature. It cannot be ignored, but you can try to not pay attention to it, or you can savor it like light drizzle, or you can hang your head and slap through puddles in huge heavy boots without noticing the sun.

Teaching how to use synesthesia is same as teaching how to use life: everyone must master it himself or herself; it is a very individual process. Though I think so, I have no experience talking about this topic. You need to listen to your body and feelings. Use less of your mind, which is always good for creativity. Not just being fearless of all the unexpected, but to perceive it with gratitude. And also, to use these qualities most often, the more you use something, the deeper you understand it, the easier you can repeat it time after time. That is, it is not exactly rocket science — a respectful and attentive attitude to everything that happens inside and constant work. Work on oneself and work in the creative spectrum involving synesthesia. Nothing happens by itself; it needs to be earned, by paying attention to it and paying for it with the most valuable currency we have: with time.

Olga Balla-Gertman:

> Strictly speaking, synesthesia is not an ability, but only a feature of perception.

Olga Balla-Gertman graduated from the History Department of the Moscow Pedagogical University. She is a journalist, book reviewer, essayist, literary critic, Head of the Department of criticism and bibliography of the magazine *Znamya* (Flag), and Head of the Department of philosophy and cultural studies of the magazine *Znanie-sila* (Knowlege-power). In 2019, Balla-Gertman became a laurate of *Furious Vissarion* ("Neistovyi Vissarion"), a prestigeous All-Russian literary critisism Award. She is an author of multiple articles, essays, interviews in many periodical paper and electronic publications; among them, *Voprosy pholosophii* (Question of Philosophy), *Znanie-sila* (Knowlege-power), and *Izvestia* (News), under the names Olga Gertman, Olga Balla-Gertman and the pseudonym Irina Schwartz. Balla-Gertman is an author of collections of essays: *Notes to the Unwritten* (in 3 Vol., Franc-Tireur, USA, 2010), *Exercises in Being* (Moscow 2016), *Dream Time* (Moscow 2018), the poetry publication in the newspaper *Mayak* in the Pushkin district of Moscow region, and in the web-magazines *Interpretation* (Prochtenie) and *Articulation*.

When and how did you learn you had synaesthesia? What were your first memories of it? How much does synaesthesia affect your understanding of yourself and your creativity? Does synaesthesia have any other impact on your life, apart from art and creativity? Is there anything else unusual or obscure that you see in the working of your mind?

When I was 12, I was amazed to learn that, apparently, other people do not feel the color of sounds, letters, and numbers (as well as other, secondary, but irrevocable and stable characteristics, which I would now call "textured" or "organoleptic": moisture/dryness, taste, smoothness/roughness, etc.). I remember it popped up while talking to someone else at the pioneer camp and left me wondering. I thought: don't people see the accompanying color strip inside themselves when they read a text, for example? Do they see everything in black and white or what? I could not imagine this "naked" perception. I confess, I still cannot do this.

Anyway, color and additional "textural" characteristics accompanied my sound perception and mastered letters and numbers since the third year (I still have a clear memory of me painting with a toxic-pink felt-tip pen, and sensing this color as an obsessive "Z" sound). I believe this perception preceded the development of the ability to read—although I was able to read from such an early age that I barely remember the "pre-letter" time. Yet, I recollect this nearly infant feeling that my mother's name was a soft green, wet-shiny, dad's name being dark brown (I would now say burnt umber), and mine was cold-transparent. All this seemed to be as normal as, for example, the fact that each letter corresponds to a sound, even if we do not hear it at the moment. And it still feels normal. Moreover, now I know that the correspondence of the sounds to letters is conventional, and the correspondence of color and sound is experienced a priori; the sense of it comes before awareness—and it (unlike the alphabet) was not learned. I do not think this affects self-understanding. Although my name was always painfully cold and slippery to me, and the full name (name-patronymic-surname) did not help much: there was not a single hot sound, no "R" (red-hot brick). It does go against self-perception. I feel rather like a hot person. In other words, this is another source of confusion.

Since I am engaged in creativity and art only as the attentive recipient, synesthesia, in my case, influences this "additional" line of perception. In general, this is life. Color characteristics of names, words, numbers, positively affect their memorization (it is easier to remember harmoniously colored numbers, with well-suited components; for example, blue—dark green) (Mysteriously, there are no light green numbers! But there are sounds). This experience is an indispensable component in the perception of what these names and numbers refer to.

The thing is, none of this seems unusual to me, as it always has been, or more obscure than, say, hearing or seeing at all. If we wanted to go into greater detail, I can "feel into" people by their handwriting, and use this basis to imagine their mental arrangement and current state. It doesn't seem very typical.

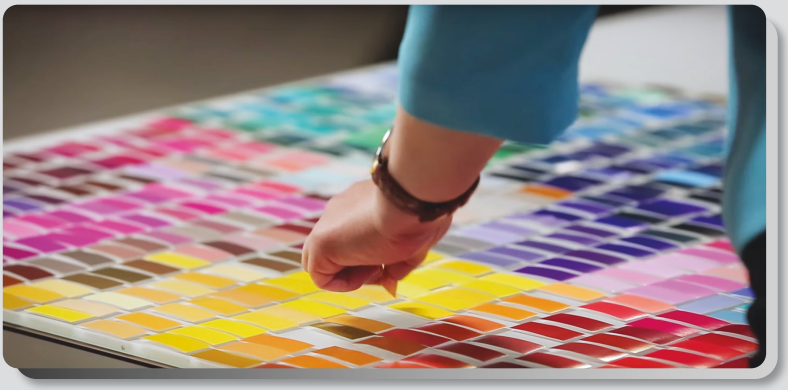
What is the meaning of synaesthesia for you? What can synaesthesia teach others? In other words, what can synaesthetes know about their inner world, surroundings or creativity, that may not be obvious, or even "hidden" from non-synaesthetes?

I think it has no meaning: meaning is only what it is attached to. If it does, it is not hidden at all, but lies on the surface: it is merely a part of a complex, multifaceted perception of what is happening—absolutely integral. If there is anything it can teach, it is that people's perceptions are arranged in unpredictable (if not very imaginable) different ways—but we seem to know that already.

It is quite difficult for me to imagine the non-synesthetic, "unpainted" perception of the non-synesthetes (when I try to imagine it, it seems to be impoverished, "naked"); so, if there is anything hidden, it is most likely not from them, but me.

How would you describe a perfect piece of "synaesthetic" art or an event from a life experience that perfectly matches and harmonizes with your synaesthesia?

Surprisingly, this is a question I've never asked. Perhaps, it is something where the meaning of what is said agrees with its color appearance, but, on the contrary, the color component of the overall picture works for the meaning.



Olga Balla-Gertman is matching her synaesthetic colours experienced in response to the names of the Moscow underground stations. Frames from a TV programme about synaesthesia, Nauka TV-channel (Science)

For example?

Here you can imagine a poem about something terrible, and it was created phonetically so that its coloristic picture makes an alarming impression (predominance of dark gray, brown, purple, red, colors, for example).

What was your first encounter with other synaesthetes? Do you understand different forms of synaesthesia that you do not have? Which one would you like to experience? (Or which not?) What kind of synaesthesia would you like to create, if you could? What do you think makes synaesthesia a part of art? Do you "suspect" synaesthesia in any creative person, if it is not known whether he or she was a synaesthete or not? Why?

I guess I only met them at L[ive] J[ournal], in the middle of the 2000s. There was no complete match of the synesthetic picture of the world with the perception of my fellows. Although, there were the "partial" coincidences in the color of individual sounds. I believe I can imagine all the kinds of synesthesia (like the connection between the visual perception of geometric shapes and bodily sensations, such as tingling in the head, itching of the legs; I do not have this, but I can imagine) — and I would like to feel all of them. The first thing that came to mind in response to the question of creating non-existent synesthesia was the connection of sound complexes and the sense of historical time: you hear a particular sound / set of sounds and find yourself, say, in 1453.

What makes synesthesia part of art, in my opinion, is what makes other modes of perception part of it: it is a human way of seeing the world and, therefore, one can work with it as an artistic "raw material". I will reveal a secret: I suspect synesthesia in general in everyone. It is strange to me that people sometimes do not have it (I think maybe they do not notice or do not admit it?).

How would you describe a perfect, absolutely synaesthetic lifestyle or situation that would come into absolute resonance with your synaesthesia, without the slightest contradiction?

I have to admit, I can't really imagine a synesthetic lifestyle. It is, of course, possible to imagine a person (conditional "me") surrounding himself only with such names, numbers, and color combinations, pleasant to his inner eye. But this would be so artificial that such a situation will have to deny to be perfection.

Which piece of art, setting, or situation, in your opinion, could serve as the perfect demonstration / illustration of the varieties of synaesthesia you possess?

I am not sure about the work of art, but the situation… — perhaps memorizing phone numbers. I remember them as color stripes. This perfectly illustrates my perception of numbers. I memorize names in the same way, and, at times, following this pattern takes me in a different direction. I always confuse "2" and "6" (colored very similarly). I was once trying to recall some "dark blue" surname: Kurbatov? Kovalev? The name was Chernykh. "K" and "Ch" are also painted similarly ("Ch" — darker, deep shade of blue), while "black" color as a meaning of the surname did not come to my mind at all.

In general, how often have you experienced situations that are in dissonance or, conversely, resonate positively with your synaesthetic experiences?

Not so rare: this happens, for example, when a nice person carries an unsympathetic (or even painfully dissonant) colored name or is the owner of a phone number utterly rollicking in the incongruity of their colors. When, on the contrary, everything coincides, it is pure joy. My first cell phone number ended with the sugary-colored, floral-looking, and flabby, sprawling numbers 23–59. I was not too fond of it (back then, you could not choose a number). When I got a new number, beautiful in its sound clarity, I was so happy.

Did any critical life event influence the emerging and developing your synaesthesia? What external factors and conditions

contribute to, or, on the contrary, suppress your synaesthetic sensations? Have you tried to do anything "against" your synaesthetic reactions; for example, suppressing their manifestation or trying to react against them? If so, how exactly? If not, why?

As far as I remember, there were no such (important) life events; there was always synesthesia: I do not remember being without it. Maybe it was the pre-speech period, of which I have very sketchy memories. But I do not remember events related to the transition to speech.

I believe my synesthesia has always been the same (as the same perception of the correspondence of sounds and letters). I struggle to remember a case when I tried to do something contrary to this perception (probably because it is very radical). Although perhaps I could call as suppression of such type a reaction to the painfully colored name of a person, if I find this person nice. (How, exactly? Just leave this reaction outside the brackets of your consciously constructed behavior.) It happened.

How do you think others perceive the synaesthesia you express in your work? Do you believe that synaesthesia separates you from them, or, on the contrary, helps you in interaction? Do you have the opportunity and desire to use synaesthesia even more widely in your work? Would you continue, even at the risk of being misunderstood?

Since I don't create anything, this component of perception remains inside me and does not affect anyone. And since I don't do anything with it, it doesn't keep me away from anyone, and if something does help, it's probably not this.

If I were to use it to make some art, I would certainly like to continue, disregarding the perception. Since the meaning of art (one of the meanings) is still to explore the unexplored paths, to identify undetected connections, I would do it for research purposes.

How do you use your synaesthesia?

I do not use it (except perhaps for memorizing numbers, names, words in general). I just live with it.

You often call yourself a bibliophile and even a bibliophage. Do you relate this to having grapheme-color synaesthesia?

I call myself exclusively a bibliophage—book eater. (The bibliophile is not me at all; it is a much more refined and culturally decorated creature. I'm just a person who swallows texts for the sake of intensity of life and because of longing for quality education not received). I don't feel any connection with synesthetic perception here.

Does your synaesthesia make you a more creative person?

Of course, no. I don't create anything. I think it's a separate group of abilities, to create new things; and synesthesia, strictly speaking, is not an ability, but only a feature of perception.

You possess one of the little-known and undescribed varieties of synaesthesia. You perceive spaces and places in color and by other sensory means. That is, the feeling of color accompanies your stay and memories of some regions of the city and not just things you call "natural boundaries". Can you share the details?

Sure, but it is not just about color, or even about it at all. It rather concerns light and texture. "Natural boundaries" can be "light" and "dark", "warm" and "cold", "sweet", "bitter" and "fresh"; "simple" and "complicated"; "high" and "low"; "arched", "incurved" and "flat"; "folded" and "smooth", "dry" and "wet" (gradation of degrees is possible here: "dry"—"wet"—"raw"—"heavy-raw"), "sunny" and "cloudy"; "transparent" and "smoky". These characteristics can be combined, of course, but not necessarily all at once. Some of the biographically significant topics: Yasenevo: cold and light, not very high, flat, and simple. VDNKh: light, cold, high, bitter, complicated, flat. Center-light—with dark spots, warm up to hot, complex, sweet, with intense relief: "folded"—very high, then deeply concave, low (not too many of such places). Dark and disturbing concave places: Taganka, one of the "darkest" places in Moscow (this place is even bitter); "Kurskaya" metro station, Zemlyanoy Val. Tverskaya is warm, even hot, intense, sweet, but darkish and mostly convex, just flat in some places, and it brightens on the squares as it approaches the Kremlin. Besides,

Yasenevo Region in Moscow that Olga Balla-Girtman synaesthetically experiences as "cold and light, not very high, flat, and simple". Photo: Raisa Sidorova

Moscow is perceived as a sound: it sounds different in various parts at different levels of pitch. There are places in it with sounds "sonorous" and "deaf", "transparent" and "opaque", "round" and "flat". It sounds round, transparent and sonorous, with small golden sounds, in the area of "Belorusskaya", along Lesnaya street, Brestkiye streets (and wide, voluminous blue in the area of the train station); flat, wide and, light, but opaque, in the area of, say, Tekxtilschiki; dull green-and-gold crumbles, like dry spray, near the Paveletsky train station.

If you decided to write a book or an essay about synaesthesia, what would you write about? What would you focus on?

I would write a book about the history of the perception of synesthesia in culture, researched and layman, about myths and guesses that accompany this phenomenon.

Michael Haverkamp:

> In the future, product designers need to be aware of all senses, not just visual aspects… I am sure that the awareness level of synesthetes is somewhat difficult for non-synesthetes to reach.

Michael Haverkamp, Ph.D., is an expert on cross-sensory design and acoustics. Until 2018, he developed methods for cross-sensory harmonization of automotive products at the Ford Engineering Centre, Cologne, Germany. Born 1958 in Gütersloh, Germany, he focused on technical and psychological acoustics during his studies of electrical engineering at Ruhr-Universität Bochum. His Ph.D. thesis addressed the physiological influences and perceptions of vibration (Medical Department, University of Mainz). He has long-term experience in product development, acoustics engineering and multi-sensory design, and studies of cross-modal perception, design, arts and music. He has had previous teaching assignments and been invited to lecture at various universities (e.g. the Köln International School of Design KISD, the University of Applied Sciences and Arts of Northwestern Switzerland FHNW, the University of Applied Sciences St. Pölten/Austria). He has numerous publications and presentations on sound engineering, perception, audio branding, multi-sensory design and synesthesia (amongst many others at conferences on synesthesia and multi-sensory perception in Spain, Ireland, Russia, China and Germany). He is a member of the jury for the *International Sound Awards*. Within the scope of contributions to arts projects and performances of improvised music, he has displayed synesthetic paintings and graphics at several synesthesia conferences. His book on his concept of Synesthetic Design was published in 2009 in German and in 2011 in English (*Synesthetic Design, Handbook for a Multi-Sensory Approach*).

Share how you came to know that you have synaesthesia, your earliest memories about it and how much having synaesthesia influenced your understanding of who you are and the related aspects of your work. Does synaesthesia play other roles in your life besides designing and creativity? Are there any other "unusual" thought processes or anything that seems inexplicable in the 'workings' of your mind?

When I was learning to read and write during the first days at school, I experienced that letters and numbers have specific colors. I was quite sure that those colors must be experienced by all people, but my classmates disagreed and believed I had gone mad. But those colors remained constant during my whole life. This applies to all characters with bright/intensive colors, like 6 (orange) and 7 (yellow). Later on, during my youth, I experienced that music has colors, too. Wind instrument tones especially show intense colors, an effect which is amplified when playing dissonant chords. Again, my fellow students considered me to be a somewhat strange guy. When synesthesia research had its renaissance during the 1990s, I became aware that I am experiencing more phenomena, like pain to color/form, colored emotions, and colored smell.

The experience of synesthesia contributed to my doubt whether the visual or auditory experiences are more important to me. Synesthesia showed me that, in my case, all sensory experiences are close to each other and the borders of modalities are somewhat porous.

Synesthesia makes my life more colorful and provides a set of phenomena which inspire my creativity. Music and sounds have colors and forms. I am not sure whether it has a further practical benefit. How is it to listen to music without any synesthetic colors?

I have a relatively good memory regarding images and sounds. I can recall visual impressions like a "slide show," and listen to music from memory. I don't know whether this can be called "eidetic" because in my case this memory is not extremely precise.

What does your synaesthesia tell you about? What can synaesthesia teach others? In other words, what can

a synaesthete know about his or her mind, world or designing practice that is not obvious or "open" to non-synaesthetes?

The main benefit of synesthesia is awareness of possible connections of the senses — enhanced sensitivity of processes of sensory integration. In fact, no one could live one's daily life with strict separation of the senses.

Furthermore, each brain forms a model of the surrounding physical world, which is just a fragmentary representation. Nevertheless, people call this representation "the reality". Synesthetes, however, are those people who already perceive that the brain adds sophisticated content to the input provided by the sense organs. For me, the experience of interactions between the senses has always been highly motivating to concern myself with fundamentals of synesthesia and to find ways of application within design, the arts and improvised music.

How would you describe a perfect object of synaesthetic design, art or work, or (if you choose to share) an absolute experience or lifestyle that feels most comfortable or resonant with your synaesthesia?

A perfect object/artwork of synesthetic design shall provide a plausible connection of sensory inputs to all people, but shall already include the specific input of the creator's synesthetic experience. Thus, a music painting may be based on a strictly subjective experience. It should, however, also include elements which make it relevant and understandable to others: synesthetes and non-synesthetes.

My senses require continuous input — always hungry for more experience. I therefore need to experience music and pictures every day, and cannot decide whether painting or music playing is more fun. As another example, I cannot touch surfaces without listening to the sound which is thus generated.

What was your first encounter with another synaesthete like? Do you understand other varieties of synaesthesia that you do not have? Which would you like to experience (and

why)? What type of synaesthesia would you create if you could? What do you think makes synaesthesia a component of exquisite design?

I first met other synesthetes during meetings at the Hannover Medical School (MHH), organized by Hinderk Emrich. I believe I can understand other types of synesthesia, or, in better words, I can accept that those types exist. In fact, many non-synesthetes do not accept that synesthetic experience exists at all. It would be most interesting to me to once experience perception without any synesthesia—but I certainly would not like to miss "my" phenomena permanently.

It would also be interesting for me to perceive more forms, especially stimulated by taste and smell. But I would certainly not like the synesthetic phenomena to overload my brain and thus to repress my daily-life perception.

Synesthesia provides important content to plausible design, because the stimuli for several modalities need optimum alignment. Firstly, all senses need to be adequately included into the designing process. Secondly, alignment of the sensations of different senses needs to be more than just harmonious; it should provide an exciting experience by itself.

What example of your work do you consider most influenced by or representative of your synaesthesia? Do you remember how you worked on it?

After studying engineering with a focus on acoustics and perception of sound (psycho-acoustics), I have been working in the automotive industry. My task was to evaluate the possibilities of my concept of synesthetic design for vehicle development. Synesthetic design enables inclusion of individual connections between the senses into design methodologies with optimum plausibility for non-synesthetes. In the automotive industry, however, the applicability of individual approaches is very much limited. Development is primarily based on trend analysis and benchmarking; i.e., exploring what the other companies do or intend. As an example, the choice of vehicle colors

depends much more on trend prediction than on individual assumptions. Therefore, my focus was on multi-sensory optimization of interior surfaces, which should "look what they feel like" and, when touched, "sound what they look / feel like". This included development of subjective test methods, perception studies, design and material modifications, etc. Furthermore, I developed feedback sounds according to visual elements on screen.

The proceeding of synesthetic design always starts with free creative/subjective approaches. As a second step, it has to be proven whether the approach is plausible to a majority of people; e.g., the customers. In many cases, plausibility can be achieved by adding further meaningful elements. Sometimes, however, the initial creative approach has to be rejected or needs modification.

Do you remember any significant life events that may have played roles in developing or reinforcing your synaesthesia? What external factors and conditions are conducive to or hinder your synaesthesia? Have you ever done anything "against" your synaesthesia; for example, suppress it or experience something contrary to your synaesthetic reaction? If yes, what? If no, why?

I do not remember any life events which fundamentally changed my synesthesia. The intensity of phenomena varies a little bit from day to day. This is similar to the effects of color: sometimes the colors which I see (through my eyes) are quite pale, sometimes very intense with high emotional impact. The same variety applies to my synesthetic colors which are stimulated by music. These colors are always the same, with a fixed relation to specific timbres, but they may vary in intensity.

Why should I do anything against my synesthesia? In my case, these phenomena do not disturb my life in any manner, and they never add any negative connotation or emotion.

How do you feel the synaesthetic regularities you apply in your designing practice are received (perceived) by others? Do you think your synaesthesia isolates or connects you

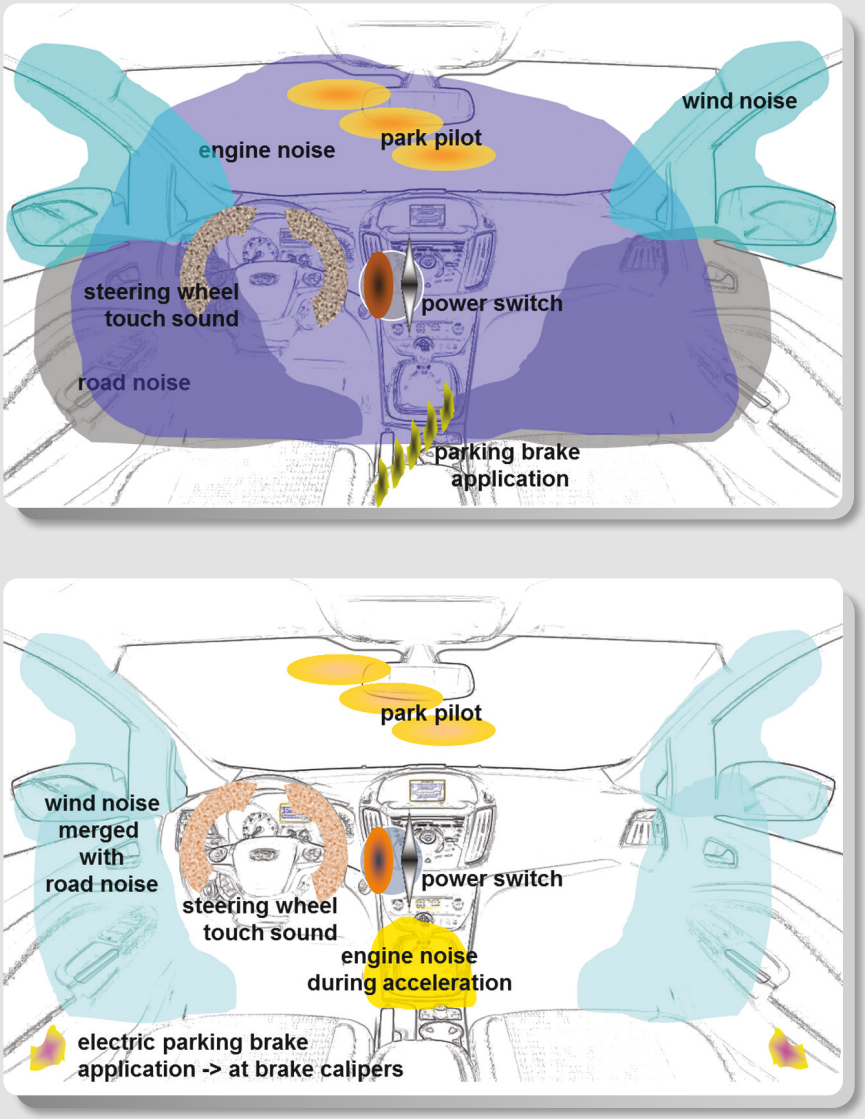
to other people? Could you use your synaesthesia more extensively in designing or product evaluation? Would you, even at the risk of being misunderstood?

There is a clear understanding needed as to which connections between the senses are understood/accepted by the receivers/customers/users of products. In order to add some extraordinary, exciting or innovative elements to the appearance of objects, synesthesia provides an additional pool of possibilities. But it is necessary to add cross-sensory correlations which are commonly accepted. Thus, synesthetic design needs to take care of both, genuine synesthesia as well as common possibilities of cross-sensory interaction, as usually applied by the human perceptual system.

I am sure that there are applications/products which allow a high portion of subjective synesthetic elements. Moreover, this is true in case of fine arts objects, paintings and films, where people much more tolerate strange appearances than they do in case of classical industrial products. Beside design and painting, I am using synesthetic impressions during playing of improvised music.

Could you provide specific examples of outcomes of your synaesthesia-inspired design process applied particularly in the projects that you worked on? How does your synaesthesia play into this?

It has not been possible to principally change the design strategy in the direction of a general multisensory design. But I was able to introduce some sort of multisensory/synesthetic thinking. A key element of this approach is awareness of how sensations of other senses are anticipated from sensations of one modality, e.g.: what does a sound look like, how would an object look like that fits to a given sound; or: how does a surface feel, just by looking at it. This synesthetic thinking showed, in various cases, that anticipation of other senses is essential to multisensory design. No one else was aware of that, and it was astonishing for many colleagues that sensory anticipation — as known from synesthesia — is an aspect to be included into design processes.



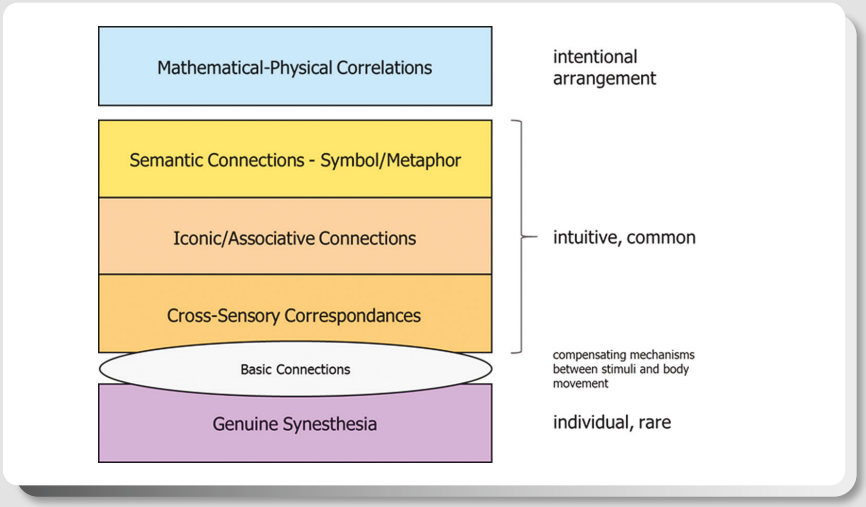
Visualization of the interior soundscape of a conventional vehicle with combustion engine (above) compared to an up-to-date vehicle with an electric engine (below). The diagrams include sound quality illustrated by colour and direction of perceived sound. Created and provided by Michael Haverkamp

Do you think that synaesthetes are more apt/able to work in design than non-synaesthetes? What special qualification or skills development do you need? Is this type of training easier for a synaesthete than a non-synaesthete?

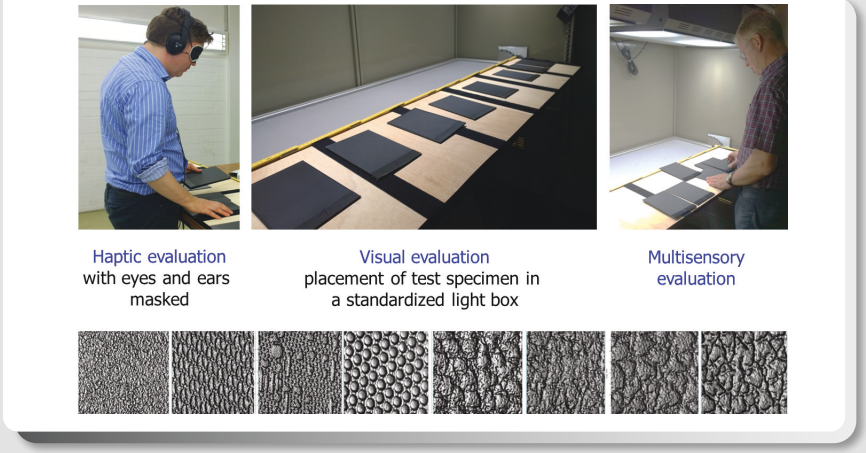
In the future, product designers need to be aware of all senses, not just visual aspects. A high sensitivity for cross-sensory relations is required, because all senses refer to the others. The best solution for a given task is achieved if the features for every sense are optimized and all features correlate across the senses. Naturally, synesthetes have a specifically high level of cross-sensory awareness. Non-synesthetes can approach this by means of awareness training ("explore the senses") to some extent, but I am sure that the awareness level of synaesthetes is somewhat difficult to reach.

What evidence do you have from your experience and reasoning that idiosyncratic, individual sensory connections in congenital synaesthesia (such as you have) can be accepted and feel plausibly apprehensible by non-synaesthetes and, therefore, be adopted into general design methodologies?

I think that exclusive use of specific synesthetic phenomena will—in many cases—not lead to a design which is plausible to most people. But a "synesthetic design" which meaningfully combines both, individual synesthetic and common features (like multi-sensory correspondances, associations, etc.), will result in plausible and exciting configurations. Firstly, you can use the idiosyncratic experience as a pool for creativity, just to enhance your set of basic design elements. If you use those elements for a design realization, you need to check the reactions of others—people without synesthesia as well as other synaesthetes, who naturally experience different phenomena. Secondly, you can add specific forms/colors of your synesthesia experience to a set of features, which are understood by a broad community. As an example, an object on the touch screen which moves up with an accelerated motion is accompanied by a sound with increasing pitch and a wind noise which underlines the acceleration. This is the part which will be plausible to most people. You can then add own



Classification of cross-sensory connections of the perceptual system [Haverkamp 2006 (*Farbe–Licht–Musik*), 2009 (*Synästhetisches Design*)]. Outline of all perceptual strategies: common/intuitive connections, specific phenomena of genuine synesthesia, and intentional/conscious arrangements. Created and provided by Michael Haverkamp



Test set-up for a multi-sensory study on surface perception. Flat samples with various textures are investigated. Diverse steps are needed to intentionally include and exclude specific senses. This takes into account all types of cross-sensory references. “Don’t ask about the perceived quality of the stimulus (e.g., sound timbre, light reflections, touch feel), but ask about the quality of material and texture (which can be heard, seen, felt, etc.).” Provided by Michael Haverkamp

experience by coloring the object in your individual colors which are evoked by the sound. Overall, this will result in a well-accepted multisensory design, because some features are plausible to most people, even if the individual part (just one element amongst others) looks unconventional.

What characteristics and features would your ideal car have if you worked on its design unrestrained by trends and benchmarking?

In the exterior, the ideal car would look like it behaves dynamically and how it sounds when moving. In the interior, the visual appearance would show the colors and forms which are best aligned with the desired ambience and aspects of comfort. Sensory features (light, sound, surface haptics) would change with operation mode and usage.

Raewyn Turner:

> My aim is for a simultaneous experience of art and meaning, where the metaphor is melded into the work and reveals itself at the same time as the sensory experience of the work. That, to me, would be the ultimate synaesthetic art experience.

Raewyn Turner is an interdisciplinary visual artist concerned with cross-sensory perception and the uncharted territories of the senses. She experiments with video, interactive installations, paintings and theatre performance, sometimes in collaboration with artists, musicians and scientists. She has worked with olfaction since 1999. She was the conceptual artist for *Multisensory Four Senses Concerts for the Deaf* 1999, 2002, twice performed as the aroma jockey for Sencity and was a design theatre artist and lighting designer for 8 years with Split Enz and ENZO. Her works have been shown in numerous national and international exhibitions, presentations and performances, including *Spectra Art and Science* symposium Australia, *Inaugural International Limestone Coast Video Art Festival*, *Mount Gambier*, Australia 2019, *The Big Anxiety Festival*, Australia 2017, and others in US, China, Czechia, Spain, Italy, Argentina, France and New Zealand. She has won several awards, including the *Wallace Trust*, *Corbans Trust Art Award*, *Kinetica NZ*, and a Fulbright Grant for an artist residency at Monell Chemical Senses Center, Philadelphia, building on her collaboration, Plume, begun in 2009 with molecular scientist Richard Newcomb, Plant and Food Research, NZ, investigating sensing of the human plume. She is engaged in an art and science residency with LAZNIA, Poland Through the Senses 2019 and 2021.

Share how you came to know that you have synaesthesia, your earliest memories about it and how much having synaesthesia influenced your understanding of who you are and your creativity. Does synaesthesia play other roles in your life besides art-making and creativity? Are there any other "unusual" thought processes or anything that seems inexplicable in the 'workings' of your mind?

When I was 17, I had a car accident where I suffered head injuries and amnesia. The first time that I felt an altered sensitivity was when my parents were driving me home from hospital. I felt that perspective of the landscape continuously opening up like a tunnel. It was giddyingly sensational, and the colours 'ticked' like when one spins around and one's vision flicks to remain ahead. I enjoy whatever synaesthesia brings but it is not so predictable—I don't necessarily experience it all the time as I've heard other synesthetes tell. Mine is variable and depends on what I'm doing. Sometimes indeed I've wondered if I have more of a form of 'ideasthesia' but then I'll have a synaesthetic experience which I'll explore by observing it and reflecting upon it.

Around that time, I also found that I experienced saturated colour with certain music, e.g., Bowie, Neil Young, *Roxy Music*. I majored in painting at Elam School of Fine Arts, where my boyfriend and his friends started an experimental art performance band. After the first couple of years, the band grew into the iconic *NZ Split Enz*. We moved to Australia and I started designing lights and reflective sets, and operating lights for their performances.

In the early 1970s, the standard colours for stage lighting were pale blue, straw and surprise lavender. It was then that I realized the possibility of using the red, green, blue palette of saturated coloured light to match the colour sensations that I experienced when I listened to music, so that I could interpret the music and paint with light. I wasn't aware of the history of colour music, so I thought that I'd stumbled creatively into a form of mapping and synchronizing music and colour together which was uniquely and euphorically satisfying for both myself and the audiences. I collaborated with the

band for 8 years. In 1996, I toured Australia and NZ with EnzSo (Split Enz with Symphony Orchestra), interpreting music with areas of coloured light over a full symphony orchestra and choir. This was followed by Four Senses 1999, where I made translations of music to coloured light and smell in a series of multisensory concerts with a symphony orchestra for deaf and disabled persons. Whenever Split Enz were awarded gold and platinum albums, I was also awarded them. The reviews often mentioned the lighting as an integral part of the performances.

What does your synaesthesia tell you about? What can synaesthesia teach others? In other words, what can a synaesthete know about his or her mind, world or art that is not obvious or "open" to non-synaesthetes?

Synaesthesia tells me about the interconnection of everything and that the collective agreement on perception and the way the world appears to our senses is a cultural construction. The current understanding of reality is current—and, although it changes with new discoveries, wisdom and power politics, it's reductionist. The world is becoming more complex and mysterious to me, especially regarding mirror metaphors, history and familial memory. I'm excited by neuroscience research that is directed towards the convergence of inputs in the brain and ultra-sensory perception.

I've taught the workshop/performance 'Internettraces/Mapping emotional words to smell and taste' several times and found that the audience/participants quite easily found the olfactory and taste equivalents to words. The process of mapping emotional words to fragrances and flavours is based on a process of reflecting on mental equivalents by testing my own responses to olfactory ciphers in order to create an art experience that may be felt in the body. Using synthetic and natural smells harvested in the local area, the audiences were asked to map the smells onto their emotions, stories and memories.

How would you describe a perfect piece of synaesthetic art, or an absolute experience or lifestyle that feels most comfortable or resonant with your synaesthesia?

To me, a resonant lifestyle is one which integrates both my emotional, spiritual and mystical journey with my pursuits to understand the reality which underlies the social, political, scientific construct. The movement and patterns in James Whitney's *Lapis* are a perfect example of synaesthetic art. The theremin is an impressive synaesthetic instrument. Jack Ox's *Ursonate* transcription painting.

What was your first encounter with another synaesthete like? Do you understand other varieties of synaesthesia that you do not have? Which would you like to experience (and why)? What type of synaesthesia would you create if you could? What do you think makes synaesthesia a component of art?

I met my first synaesthete when I worked with a commercial perfumer. Louise Crouch uses words and colour to help her in creating mixtures. She didn't call it synaesthesia but a system to remember fragrant materials. It was exciting to work with Louise because she makes creative and synaesthetic interpretations. Richard Newcomb says that we have senses that we don't know that we have until they're named. I've found that imagining, exploring and experimenting with other varieties of synaesthesia that I don't have helps me to understand them and sometimes to realize that I do! When I found out about spatial synaesthesia, I realized that I 'draw' loops connecting vertical lines, e.g., between trees, power poles, landmarks, buildings. So then I created a movie 'STAVE "Oh that I Had"'.

I'd like to create touch-smell synaesthesia, and spatial-music synesthesia! The molecular and fractal vibrations of the universe that are mirrored in the micro and the macro are manifested as sound, light, smell, touch, taste, gravity and movement. I'm interested in how we make sense of the world and we construct meaning out of fragments, re-interpretations and making changes. I use my synaesthetic experience to make art because I want to share it. I'm bringing things together not only in the content within the art work but also in the art work's structure and mediums — colour, taste, odour, sound, texture, movement in visual, olfactory, auditory, proprioception, touch, taste, personification. I experiment with making translations and

intersensory correspondences that will integrate the senses together. As a visual artist, my synaesthetic experiences inform my approach to making multisensory art. Engaging the other senses has been made more possible through the use of video, digital media, electronics and also working in collaboration.

What piece of your art do you consider most influenced by or representative of your synaesthesia? Do you remember how you created it? What other artists not known to have synaesthesia do you feel were nevertheless synaesthetes? Why?

An example of an artist who must be a synesthete is Samson Young, who's re-presenting and re-interpreting overlooked events of socio-political and personal significance in his *Muted Situation #22: Muted Tchaikovsky's 5th*, 2018 in the Sydney Biennale, foregrounding the unnoticed sounds of an orchestra. His muted works about the expectation of sound create a visceral feeling of a wordless language for me. Helen Pynor's video work where a sleeping man's body was being shifted around made me feel as if the movement of his body was also mine. I feel that she's an artist with synaesthesia because several of her visual images trigger an empathy (I feel what's in the image) and occasional sound.

I have a few works representative of my synaesthesia. In 1998, I was invited to interpret music with a symphony orchestra for deaf audiences in the Four Senses series of performances. I wanted to engage and reframe perception of music and to play with simulated synaesthesia and subjective experiences. I placed the audience within and amongst the orchestra, and interpreted classical music into patterned shifting projected light. Fragrances associated with various historical periods relating to the music were sprayed into the ceiling cavity.

The second series of concerts, *Four Senses 2002*, were performed by *the Aotea Youth Symphony Orchestra* and included mixed ability dance group *Touch Compass*, deaf signing choir *Hhands*, and sight-impaired vocalist Caitlin Smith. Tactile cushions and balloons were available in the auditorium for those with hearing disability. The pre-programmed light states were created with a PC based stage-lighting

program to make a light resource, along with fragrances, of multiple sequences and cues available for improvised use; each piece of music had its own improvisation resource and structure. The canvas of the orchestra was dressed in white, underlit with ultraviolet light (bluish, white and uv), which is a base colour 'note' found in nature. I invited Tony Brooks (UK) to collaborate. He utilised sensors, cameras and other technology to capture the movements of the orchestra, translating it into coloured light. In this way, the orchestra conductor was able to "paint" the scene through his gestures within an interactive space. Similarly, orchestra members, dancers and a special signing choir for the deaf images were blended into the backdrop in real-time such that their velocity of movement affected the colour of image generation and collage composition.

My first step in making a perceptual analysis of music is to make a drawing of music in pauses and phrases as a description of sound. This puts sound into a relationship with other experiences, specifically a visual experience of light and dark. I interpreted sound to light by coding phrases of sound into light and the pauses into dark, so making correspondences between sound/silence and light/dark. The method involved intuitive drawing, charts, measurements, referral to the seasonal time of harvest of aromatic plants, and an equation which produces a selection of plants from which to choose smell pitch. The chosen smell elements were orchestrated in an improvised layering of preselected fragrances of different pitch, throughout each piece of music.

Do you remember any significant life events that may have played roles in developing or reinforcing your synaesthesia? What external factors and conditions are conducive to or hinder your synaesthesia? Have you ever done anything "against" your synaesthesia; for example, suppress it or experience something contrary to your synaesthetic reaction? If yes, what? If no, why?

Until the 1990s, I was unaware of the term 'synaesthesia' or 'colour music'. In 1996, I read the book *The Spiritual in Art: Abstract Painting 1800–1985* and I learned about Oskar Fischinger and James Whitney.

I was not alone! In 2000, I read the Leonardo Synesthesia Special Project by Jack Ox and Jacques Mandelbrojt. I felt that this was related to my hybrid work and I contacted Mandelbrojt, who subsequently invited me to present my works at the *Intersenses and New Technologies* Symposium in Marseille. This symposium was the first time that I had heard about the synaesthesia of proprioception, Jack Ox's colour organ for the 21st Century, and about the work being done by Laboratoire Musique et Informatique de Marseille, MIM to map music to colour. However, even when I became familiar with its meaning, I avoided applying the term 'synaesthesia' to my own work because I didn't want my work to be categorized within a genre, although this might even have afforded my collaborative work in coloured light/music to be regarded as more than wallpaper to the rock and roll stage. I'd developed an active art practice of experimentation with light, collaboration and live performance but it had been largely regarded as a background to the music and not proper art. I wrote essays on the art of light, which were published in two music publications.

I occasionally mention my synaesthetic experiences and compulsory mapping with my family and friends; but, in general, there's little interest in one's personal experience of synaesthesia outside of the art-science synaesthesia groups and neuroscience. Hopefully, the works that I make express a feeling for synaesthesia.

How do you feel about the way the synaesthesia you express in your creativity is being received by others? Do you think your synaesthesia isolates or connects you to other people? Could you use your synaesthesia more extensively in art-making? Would you, even at the risk of being misunderstood?

Synaesthesia expression enables us to encompass a wider spectrum for experiencing this world. As a work evolves, it often dictates what it needs in terms of expression, so not all my work is focused on synaesthetic experience or translating intimate resonances. The art works usually evolve from experiments over a period of time, in a process of unfolding.

I'm interested in unconscious smell molecules and how they affect the mind. When I work with fragrance materials, I experience

geometric planes and tones, which helps me to perceive and remember the 'incline' or the 'geometric cypher' that each one is expressing. I hope that my testing of subjective resonance on myself will carry across to create integration in the work. My work comes from my intimate experiences of family life, my interest in scientific theory and practice, and reflections on mass media piled atop of personal observation and shifting interpretations. Sometimes, I work with scientists in laboratories to collaborate and gain knowledge of science research and practice. My question is about how we make sense of the anthropological, geopolitical, biological and synthetic environment. I'm interested in subsensory and unconscious synaesthetic experiences and their contribution to emotional meanings.

I'd like to create a work that looks back at humanity and reveals the symphony of marginalized sensory effects that are having an unconscious effect on perception; to create synaesthetic sensory parallels, an intricate weaving together of sound, olfaction and light, to reimagine and reveal a fabric that surrounds us; for example, the background layers of the chemical and petrochemical atmosphere, the sound of a thousand electrical and tinnitus hums, and the light of millions of colours powered by the ocean heat uptake due to global warming.

In Marcel Proust's *In Search of Lost Time* (1913–1927), the author renders a famous episode with a madeleine, in which a faint hint of flavor triggered a galloping flashback for the narrator who lived more than a century ago. You create through extensively using technological mediums. What influences do you think burgeoning technology has on contemporary people's sensoriums and sensory correspondences? What does this mean for synaesthesia, creativity and art-making?

Technological mediums are giving artists more tools to re-represent sensory material — video, audio, touch, taste, smell — as well as giving them the autonomy and self-sufficiency over making and showing their work. I work across mediums depending on which medium the work requires. I ask questions about technology's relationship to humans and its incorporation into everyday life. I'm interested in the intertwining of

Raewyn Turner and Diana Burgoyne, *ReSense*, 2010. The work examines synthetic synaesthesia (the smell of green) and anaesthesia of place (feeling numb to its history and changes). This interactive exhibit utilizes video, smell, sound, electronics and digital media in a collaborative process between two cultures and two communities, New Zealand and Canada. Co-Produced with the Banff New Media Institute 2009, exhibited and presented in MuVi2, in the Third Congress 2009 Synaesthesia: Science & Art, in Granada, Spain

Raewyn Turner, *Steep#1,* a digital poetry of gold nanoparticles. 2015. A frame from a video of the performance (original: 4.31 minutes). Steep#1 explores sensing gold nanotechnology, where it accumulates, changes over time, and how it may affect living beings and the environment. In the absence of a visceral sensing, Steep brings attention to the possibilities of perceiving invisible airborne particles

human and technological sense, in the effect of sensory layers of interpreted data which overlay and combine with bare sensory reality.

Any technological device that captures and records data that can then be transmitted, stored, and analysed is never going to tell the full spectrum of truth. Technological mediums tell us about a mechanistic understanding of materiality with limited resolution and limited selection translated by algorithms the design of which are subject to the imagination of the programmer. Despite their limits, the output they generate is raw material which can then be transformed and reassembled into cross sensory experiences. The technology can transform the touch radar into maps, transmit real-time communications, sound synchronized with colours, make the silages of fragrances last for weeks, and we're mesmerized, even addicted to what the technology does.

Since 1999, I've worked with olfaction. The palette of olfaction is similar to that of colour; each smell has its own meaning and correspondences and is in relationship to everything else. Since the end of the last century, images, sounds, smells, tastes acquired an instant mobility which has given them a new contextual and synaesthetic meaning. The visceral senses are intimately subjective but also rely on context. Context affects meaning and the associations can be changed by context. The context is the many wrap-around layers of our social, economic, political, real and sensed environments constructed with novel materials, 'millions of colours' on screens, synthetic dyes, synthetic fragrancing, flavouring and deodorizing, instant communications, electronic sound, advertising, commerce, new material properties, textures, light sources, etc.

Smell may acquire more of a hedonic weight than the other senses due to its direct pathway to the limbic (emotional) centre before being relayed to the centres of translation into sensation. The impulses from the olfactory bulb may therefore be more weighted with feeling before they reach the interpretive part of the brain. Odours that can't be detected may also be associated with sub-auditory and visual material that is beyond human bandwidth.

You ask about what influence technology may have on people's sensoriums and sensory correspondences. If unconscious sensory experiences are altered by the presence of airborne, ingested, transferred novel manmade particles, I propose there may be correlating cross-sensory or inter-sensory experiences. Engineered nanoparticles are added to materials in production to produce 'magical' effects; for example, novel tastes and sparkling visual effects. Nanotechnology allows the possibility of new qualities to be added to materials: colour, penetration, solubility, transparency, chemical reactivity.

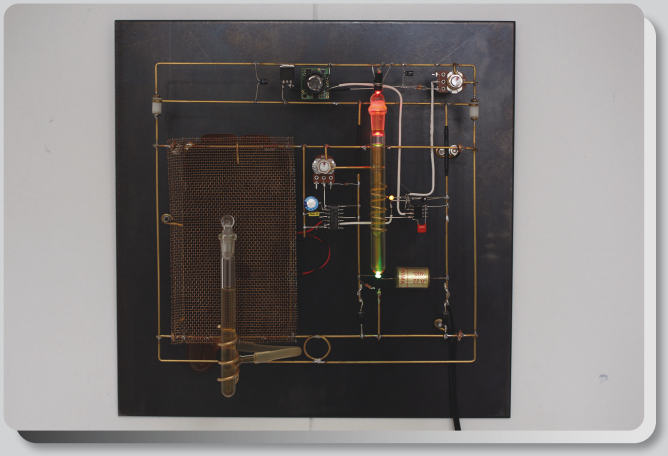
What are the inter-sensory correspondences of novel materials and experiences? What can be perceived? Both colour and nanoparticles have intrinsic and extrinsic properties at the same time. Colour is relational. So too is nanotechnology.

We don't have any sensory organs that can perceive nanoscience but we have synaesthesia, pareidolia (finding shapes, such as faces, in inanimate things), sensing emotions in inanimate objects, and changes in wavelength. The fusiform gyrus and the amygdala are two regions in the brain which offer connections to synaesthesia, pareidolia and feeling emotions in ambiguous things.

The fusiform gyrus is where the processing of colour information, face and body recognition, word and number recognition and perception of emotions in facial stimuli takes place. According to Ramachandran, it is also the area activated during subjective grapheme-colour perception in people with synaesthesia (Ramachandran, V., *3 Clues to Understanding Your Brain*, Ted Talk 2007, www.ted.com).

The Smell-O-Vision system was short-lived for the reason of its difficult maintenance and troublesome application. What's more, the visceral senses are, on the one hand, very intimate and immediate and, on the other, can convey only imageries that are experientially familiar to the audience. You are one of the few artists who aim to turn to the visceral senses. How do you transcend these essential limitations and difficulties to get your own artistic message across?

Raewyn Turner and Brian Harris, *Dolorimeter*, exposed at the IASAS Los Angeles Symposium 2017, Building Bridges Gallery. Dolorimeter explores pain and how it is perceived in the body. When the stone is put under pressure/pain it triggers a rod to vibrate. The vibration of the rod makes a smaller stone in a dish tremble which releases the fragrance of rain (geosmin). The work refers to intersensory sensing where micro electrical signals and data are captured and transformed by algorithms and digitally mapped into simultaneous cross sensory experiences



Raewyn Turner, *Dark Perfume with Integrated Circuits*, 2017. The electronic circuit is laid out to represent its schematic diagram within which are two integrated circuits. It holds both a fragrance and a background odour. When the work is approached to sample the perfume, the electronic circuitry emits a second earthy fecal animal odour. The work refers to collective memory and computational memory, and the tension between forgetting and remembering, inspired by the line "our memories mislaid by the rain" in Ishiguro's Buried Giant

Some of the challenges of working with the visceral senses are that the material used in them is often ephemeral, they're difficult to control, and the context of art highlights their awkwardness as suitable materials. Their enormous power to communicate at an emotional and intuitive level has yet to be liberated from the context the perfume bottle, the cleaning product, food or the ritual, to become the conjurer of synaesthetic images and associations.

Smell-o-vision was an unfortunate application of linear correspondences, whereas it could have served to emphasize the wonderfully vast range of synthetic olfactory sensations disconnected from the 'things' that they're usually associated with. Film and video present an opportunity for abstract, synchronized visual, audio, olfactory play with spatial mixing and sequences.

Some experts claim that synaesthesia, as more than often implemented in art-making, is just literal depiction of automatic and superficially meaningful reactions. As an artist working with synaesthetic correspondences, how do you address the issue of synaesthesia being labelled as a mechanistic, predictably patterned experience?

I want to bring sub-sensory signals and their 'equivalents' into perception — for example, things that are invisible, inaudible or anosmic — and for this I use my subjectivity and reflection on intersensory perception and feeling. For many years, I didn't use the term 'synaesthesia'. I called it equivalents, correspondences or matches.

My synaesthetic experiences are unpredictable because they're related to my internal life and the mutable environmental soup in which I'm immersed. I may intend for synaesthetic art work to be experienced a certain way but of course it will be interpreted differently because of each person's experience of the world, their perception and the context of the work.

My aim is for a simultaneous experience of art and meaning, where the metaphor is melded into the work and reveals itself at the same time as the sensory experience of the work. That, to me, would be the ultimate synaesthetic art experience.

Lidell Simpson:

> I am a polymodal synesthete... I have been deaf all my life and I have never known silence… My synesthesia revolves around sounds. Vision to sound is my dominant form.

Lidell Simpson was born in New Orleans, Louisiana, and lived all his life in Mississippi, USA. Simpson graduated with a Bachelor's degree in Biological Sciences and an Associate Degree in Bank Operations from Hinds Community College. He worked several years in Information Technology departments of Sunburst Bank and International Paper. He retired as Senior Production Control and Operations Analyst from SAKS Incorporated. Lidell Simpson is a deaf polymodal synaesthete. He is also the second known possessor of the phenomenon call deaf hearing, a condition in which deaf individuals are able to react to an auditory stimulus without actually being able to hear it. He attended his first *American Synesthesia Association* (ASA) conference in San Diego in 2002. In 2005, he gave his first synaesthesia-related talk at the University of Texas. Since then, he has been very active in the conference circuit, giving talks in the United States, Germany, England, Spain, and Russia. He takes delight in meeting synaesthetes and researchers worldwide, exchanging experiences and ideas to further advance our understanding of synaesthesia and its impact on neuroscience and other applications. Recently, Lidell was filmed for the joint French, Canadian, and German television documentary titled *HUMAN +, The Future of our Senses.*

Share how you came to know that you have synaesthesia, your earliest memories about it and how much having synaesthesia influenced your understanding of who you are and what the world is like for you. What roles does synaesthesia play in your life? Does it make you more creative? Are there any other "unusual" thought processes or anything that seems inexplicable in the 'workings' of your mind?

I am a polymodal synesthete. My favorite saying is "I have been deaf all my life and I have never known silence." It is certainly not an oxymoron as it appears to be. My synesthesia revolves around sounds. Vision to sound is my dominant form. I also have smell, taste, touch and emotion to sound synesthesia. I call my emotion to sound synesthesia "Emosyn". In short, all of my sensory experiences get translated to sound.

I have profound congenital sensorineural deafness. It is due to problems when the cochlear or auditory nerve is damaged or underdeveloped. When I was three years old, my grandmother noticed I did not turn my head when she ran the vacuum cleaner behind me.

My anxious parents took me to a developmental psychologist and an audiologist. That day is one of my most vivid memories of early childhood. My testing at the clinic was nothing short of an unmitigated disaster. I recall sitting in the soundproof audiology booth. Headphones were placed on me and I sat in front of an abacus. A tone would be sent to me and I was to move an abacus bead when I heard a sound. It was just play to me, moving the beads back and forth. The result was inconclusive and the clinicians opted for what they called a "more definitive test". The test took a page from Ivan P. Pavlov and B. F. Skinner on operand conditioning. I sat on my mother's lap. Electrodes were glued to both of my legs. During the test, every time a tone was emitted, I was given an electric shock. The idea was that, over time, I would be conditioned to react in anticipation of an electric shock upon hearing a tone. I kicked and screamed nonstop after the first shock. Nothing else mattered.

The doctors made an astonishing diagnosis: I was not deaf but had aphasia instead. They said I would be severely developmentally

disabled. This was in 1961. The doctors also explained that I would never be able to acquire and grasp language. The logic was that, if one can't think in "words", there could be no intellectual development. Months later, I was taken back to Memphis, to Dr. John J. Shea, Jr., a world-famous neuro-otologist. Dr. Shea's diagnosis was sensorineural deafness. Although he did not consider me to be developmentally disabled, he was also somewhat pessimistic. He said I would never talk and I should be enrolled in a deaf school. That meant my parents would have to move to another city where such a school was located. He was adamantly opposed to hearing aids because he feared it would cause me to lose what little residual hearing I have left.

My parents left his clinic and went two blocks down the street to a hearing aid vendor. Within two weeks, I was fitted. I remembered my first experience with the sounds of the city. The passing cars, squealing brakes, the pounding of the pile drivers at construction sites. Finally, most importantly, hearing voices for the first time. The world changed. A whole new level of sensations. My synesthesia evolved and expanded as a new "language".

What does your synaesthesia tell you about? What can synaesthesia teach others? In other words, what can a synaesthete know about his or her mind, world or art that is not obvious or "open" to non-synaesthetes?

My synesthesia is two-fold: natural and acquired synesthesia. My natural synesthesia bootstrapped my acquired synesthesia which arose after being fitted with hearing aids. People with missing senses will be compensated by the enhancement of the other senses. In the case of the blind, the sense of touch is sharpened. I was the same way with my touch to sound synesthesia. I will hear whatever touches me or whatever I touch. A gentle swooshing sound would be heard as I felt a gentle breeze brush against my skin. I hear different sounds for different textures as I run my hands across a surface. I took delight eating, hearing the sounds of the tastes and spices.

I hear motion. Every person's gait gives a unique sound signature. Often, I can recognize someone I know or previously met in the

distance by his or her gait before seeing the face. The syn sounds convey the information of "Who". My natural synesthesia reflected my understanding of the world around me. As I learned more, additional synesthetic responses were acquired. When I observed a door closing, I heard a "Sweeeee" as the door moved open or close. I never heard it shut. After being fitted with hearing aids, I heard the door shut and knew the sound. From then on, with hearing aids off, observing the door closing, I heard a "Sweeeeee-Thunk". The "Thunk" was acquired. The sound of the "Thunk" is relative to the speed of the door closing.

I find my synesthesia to be advantageous. The synesthetic sounds are the bedrock of my thought process. I think in these sounds, not in words or visual imageries. To think is to produce a symphony of sounds in my mind. From these sounds, my expressions emerged. When I related this to Richard Cytowic, he called it "Sprachgefühl", an intuition from which language springs.

I may be biased but I do feel that many synesthete artists' works are often a cut above many of their peers and even at times rather "outside of the box". A genius can hit an unseen target. There have been many discussions about the link between creativity and synesthesia. I do not believe having synesthesia guarantees one any artistic talents. I know one well-known British synesthete who admitted to me he doesn't have a lick of any kind of talent. At a conference in Hannover, I was sitting at a lunch table with David M. Eagleman and Richard E. Cytowic. I was commenting on an earlier presentation regarding talent and synesthesia. I said "Talent and intelligence has nothing to do with just having synesthesia. It is what one does with it that matters."

How would you describe a perfect synaesthetic situation, and/or an absolute experience or lifestyle that feels most comfortable or resonant with your synaesthesia? What piece of art, setting or situation do you consider most representative of your type(s) of synaesthesia? In general, how often do you feel that your synaesthesia is discordant and concordant with the world "out there"?

Most of my ideal synesthesia experiences are at night time. I would go out to an observatory not far from home. I did not merely go out to look up into the sky on a clear night to see the stars twinkling. I came out to HEAR the celestial symphony of the stars. Often, I felt pity for all those around me not able to hear this beautiful cosmic dance music. The "Music of the Spheres".

Looking at a Vincent van Gogh's *Starry Night*, his deep and thick brush strokes screamed out. I spent hours at the Van Gogh museum in Amsterdam to listen to the swirling, gliding paths of his brush strokes. Its depth spoke to its intensity of the artist's emotion. A rage of passion. My past two trip to Russia afforded me a few unusual synesthetic experiences, not only in their rarity but their intensity. Various sounds were emanating from the seascapes by Ivan Aivazovsky. The colors and contrasting brightness blared forth along with hearing the sounds of the sea waves. When I first entered the Red Square at night time, I was overwhelmed. A rare experience of vision to taste synesthesia stood out. I was not just hearing the lighting and the colors of the scenery; I started to taste them. I walked around slowly, soaking it all in. Only when I walked to the other side of tasty St. Basil's and the Kremlin did the overwhelming taste subside. The only thing left was the warm vibrating hum emulating from the Hotel Ukraina, with a faint aftertaste of a raisin croissant ahead of me.

Often, I drive with the radio off because, most of the time, the music just would not match my synesthetic impressions of my surroundings. Too much discord would distract me from my driving, disrupting my spatial sense. In the "real" world, I can only hear sound as omnidirectional. I have poor skill in locating sounds. My synesthetic sounds are neatly laid out in 3D space. Rock music often resulted in a train wreck of noise. Classical music tended to work sometimes if I don't overreact to it.

Sometimes, my surround can interfere. When I eat, l like to hear the food and spices. Berit Brogaard recalled what I told her: "Recently I had a most beautiful and tasty lamb shank. Sadly, the restaurant was quickly full of people and all the noise of the chitter chatter was so great that I could no longer hear the taste. That was when I lost

all the flavor. Just bland. Turning off my hearing aid would not help since a little ambient sound helps the taste. Russian synesthete Solomon Shereshevsky said the reason soft music is played in restaurants is to make the food taste better. I agree" (Brogaard, 2015, p. 183).

What was your first encounter with another synaesthete like? Do you understand other varieties of synaesthesia that you do not have? Which would you like to experience (and why)? What type of synaesthesia would you create if you could? What do you think makes synaesthesia a component of art (if you do so)?

I attended my first *American Synesthesia Association* conference in San Diego, hosted by Vilayanur S. Ramachandran. It was my first encounter with synesthetes. Sean A. Day was the first one I have met and I finally got to meet Cytowic face to face. A significant amount of time was devoted to the discussions of colored graphemes. Serious scientific research into this was at its very early stage. Questions were flying left and right after each presentation. I was pleased when Ramachandran said I had been asking many good questions. Three years later, I finally gave my first presentation at the conference hosted by David M. Eagleman in Houston. I played a musical piece I composed to show what my synesthesia sounded like. I was surprised; I got a standing ovation at the end. Most synesthetes will tell you that the experience is mundane. They do not walk around all day saying "Wow" at every experience. To them, it is normal perception. In the audience were some with colored hearing who told me it evoked a very vivid response like never before. On the other hand, Day's visual response was a rather boring fuzz of pink cotton candy.

Do you remember any significant life events that may have played roles in developing or reinforcing your synaesthesia? What external factors and conditions are conducive to or hinder your synaesthesia? Have you ever done anything "against" your synaesthesia; for example, suppress it or experience something contrary to your synaesthetic reaction? If yes, what? If no, why?

When I was about 13 years old, I asked an innocent question to a group of friends. Naturally, I thought then that everyone pretty much perceives the world the same way. Little did I know how different my world was. "Do y'all hear this radio tower lights blinking?" It was met with laughter and teasing. Later that day, I asked my parents the same thing. "Nope" was their reply. I thought, this was strange. I asked again and again and no was still the answer. Since then, I never said anything about it to anyone. I started to re-examine myself, asking "What IS going on?" Despite what everybody else said, I was not particularly worried about it, since I was already fully oriented with the world.

My synesthesia is not without its problems. In the past, I often suffered from sensory overload. Over time, I learned to avoid the triggers that would make me uncomfortable. I have learned the hard way that alcohol is the worst thing I can do. Cytowic wrote: "Alcohol amplifies his synesthesia. He says a few beers in a quite setting are manageable, 'but at a very noisy bar I am courting disaster'" (Cytowic & Eagleman, 2009, p. 103). The biggest problem in the past, dealing with these sensory overloads, were the doctors. Most were not receptive to the idea of synesthesia and insisted I was epileptic, despite all testing proving the contrary. I often faced a dilemma whether to inform the doctor about synesthesia. I leaned at the time it was not the best thing to do. One psychiatrist suggested I was bipolar and was determined to cure my synesthesia once and for all. I took the medicine samples and prescription he gave me and tossed them into the garbage as I left his office. At that point, I decided to write to Cytowic.

Not having a word for my strange perception of hearing what I saw, I called it "Photonic Hearing". My early research was rather discouraging but I was convinced I was not hallucinating and found the word "synesthesia". Information was scant and it was often described as an abnormality. I discounted that characterization, since my synesthesia is meaningful and consistent. I wrote about it, to a degree, while studying German, reading Immanuel Kant, in an essay. I described my thought process. It was entirely non-verbal. It was a thought process of pure sounds. Every word, idea or concept was represented by a sound. Not only did I hear it, I felt it too.

In 1979, I was studying Abnormal Psychology at the University of Mississippi. I was then already aware of colored-grapheme synesthesia. Excited, I described my synesthesia to my Psych instructor and proposed a survey, hopefully to find other synesthetes. My instructor nixed the idea and suggested I get myself checked. An argument ensued, to no avail. That was the very last time I raised the subject for almost 20 years. Ever since my first awareness of my synesthesia, I have been interested about the inner workings of the brain.

One day, in 1994, I read a book review in *TIME Magazine* about Richard E. Cytowic's book *The Man Who Tasted Shapes*. I lit up. I ordered a copy and read it. This was it! It made sense to me. It was a relief. I considered the matter settled. Eight years later, I wrote a long letter to Cytowic. I referred to it with a syllogism, calling it "Fühlengedanke" or "Feel-Think". My thought process was all "Emo-Syn". I was having difficulty with my synesthesia manifesting as sensory overloads. It was interfering with my work and I asked if he knew of a neurologist he could refer me to. He sent me to Dr. T. The doctor was very interested and sympathetic about synesthesia. Cytowic published an excerpt of that letter in the book *Wednesday is Indigo Blue*:

> "I also hear with equal clarity other things that are not 'sonic.' Photonic hearing to me is the result of light. My eyes are another pair of 'eardrums' to me. Every color "emits" a tone. Intensity, brightness, position — all influence the 'tonal' quality of these emissions. For example, there is a radio tower miles in the distance. On the towers are a series of lights, red or white (each color has its own 'note,' 'tone', or 'key' if you will). I hear the blinking lights and its intensity increases as I approach. Now add the reflectors along the side of the road. Every one of them emit its 'ping', and the center striping of the road emits its own sound. Every car headlight has its tune. The tonal quality changes with respect to relative position, like the Doppler Effect. Even in the daytime, same thing. I hear the sky, the trees, anything my eyes perceive emits sound."
>
> (Cytowic & Eagleman, 2009, p. 103)

How do you feel about the way your synaesthesia, when you share about it, is being received by others? Do you think your synaesthesia isolates or connects you to other people? Could you enhance or use your synaesthesia more extensively in adapting to or transforming the world? Would you, even at the risk of being misunderstood?

I leaned at first it was a subject best avoided. Cytowic's publication *The Man Who Tasted Shapes* changed everything. It was at last a vindication. Like myself, since the book's release, many came out of the "synesthesia closet". I have heard many stories from others about how that one singular book changed their lives. Today, I am very much open about my synesthesia. The general public is interested in learning more and finds it fascinating. It must be made clear that synesthetes are not "evolutionarily superior" or representing a future of human evolution. Despite all of the public interest, I feel that it has not resonated well, nor been taken seriously enough by primary care physicians. Hopefully, that will change in the future.

Has your synaesthesia ever been scientifically studied? (If yes, share how!) How do you feel about being studied? What would you like to know about synaesthesia that is not yet discovered? What recent discovery about synaesthesia was most revealing to you?

I was a study subject under the direction of the late Hinderk M. Emrich of the Medizinische Hochschule Hanover. The study was carried out by Janina Neufeld and Christopher Sinke; part of the study was modeled after research done by Melissa Saenz and Christof Koch (Saenz & Koch, 2008). A fMRI was done in an attempt to find any cross-activation.

One test involved rhythmic temporal sequences of a flashing dot like Morse Code. I was shown two sets and had to determine if the sequence of each of the two sets was the same or different. The first phase was done with the flashing dot with an audio beeping of the sequence. Both synesthetes and controls did well on this part. For a non-synesthete, it was far easier to make the determination based on

the audio sequences. The next phase was done without audio. It was a series of rapid flashes. The non-synesthetes performed poorly. It mostly became guesswork on their part. My performance without the audio exceeded that of the control group.

You say that you "would hear the door closing twice! One by my acquired dimension of my vision to sound then two by the actual sound picked up by hearing aids." Can you share how else the sounds that you hear are qualitatively and quantitatively different from the sounds that you experience synaesthetically? How do these sounds interact between themselves, if they do so?

It is hard to say. I experience two separate realities simultaneously. I have to give credit to Sean A. Day for that notion when he said that during our conversation with other synesthetes during an American Synesthesia Association conference that was hosted by David Eagleman. When I watch a door close with my hearing aids on, the syn-sound and the real world sounds match. They are layered on top of each other in my perceptual world. There is no conflict. As I said earlier, if the door is far enough away, people will see the door shut before hearing the sound. I will hear it synesthetically when I see it shut, then I will hear it again sonically when the sound arrives later. Of course, I would not hear any other sound associated with a shutting door because I learned after fitted with hearing aids what it is supposed to sound like. Naturally, before wearing hearing aids, I heard no synesthesia sound of a shutting door; simply, I did not know nor experienced its real world counterpart. Sounds in the real world can be masked by other sounds. For example, we are outside by an airport runway having a conversation, and a jet plane goes by; the noise from the plane's engine would overpower to sound of our speech so that no one can hear what is being said. On the other hand, I can still hear synesthetically the voices by lip reading. My point is that, no matter what goes on the real world, nothing can ever mask the sounds I hear in the synesthetic world. Do they interact? They do not and they should not in order for me to maintain

my orientation. For me, real world sound is omnidirectional. Even with hearing aids, I have never really learned to determine the direction of sounds because the hearing loss in my ears is not balanced. The synesthesia sounds I hear exist in my mind in its own 3D synesthetic space.

Over the course of your life, you have encountered quite a lot of pseudoscientific and mystical approaches to synaesthesia. Could you comment further upon the current trends regarding such misconceptions seen on the internet, such as on social media?

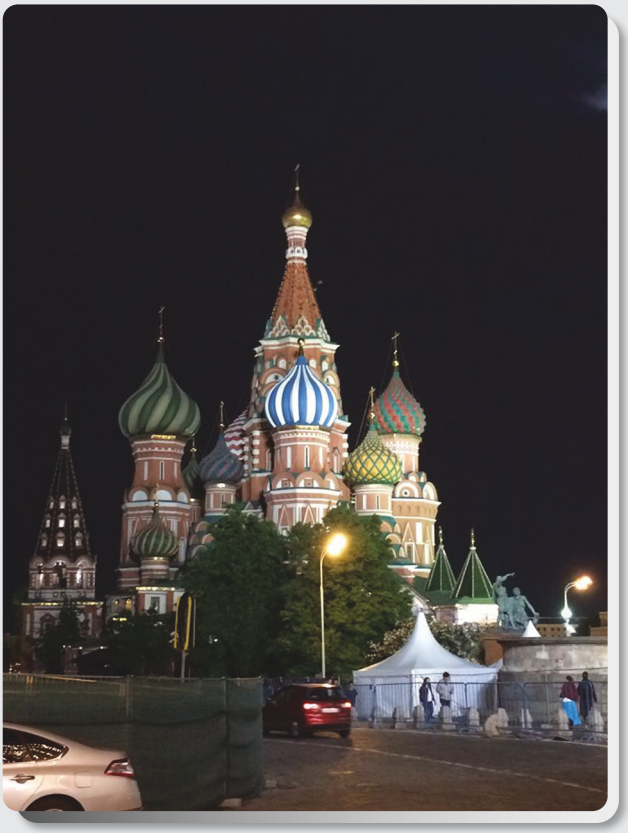
In the mid 1990s, I accessed the internet for the first time. Before long, I was doing searches on synesthesia. Eventually, I discovered Sean Day's website and his synesthesia list. That was the beginning that synesthetes worldwide had an open forum for discussion. Over the years, I have read the submissions by synesthetes. I never thought that, several years later, I would finally meet Sean A. Day as President of the newly formed American Synesthesia Association, which was co-founded by Carol Steen and Pat Duffy. Later on, Facebook arrived and it opened a new door and more people than before were posting about their experiences and questions. Many felt comfortable talking about it online and, at the same time, many were reluctant to broach the subject with non-synesthetes, out of fear of being ridiculed. Cytowic's book *The Man Who Tasted Shapes* detailed his study of MW's synesthesia. That started a renaissance in serious scientific research. Since then, there have been many news stories and documentaries about synesthesia. It has gone mainstream with the public. But, despite it all, it has not gained much, to the frustration of many synesthetes; not gained a real inroad with the medical profession. Maybe in the near future this will change. Joel Salinas's book about Mirror Touch synesthesia may have open the door even more, getting doctors to pay more attention to it. I am delighted to see all these FB pages relating to synesthesia and people are educating each other about and the science behind it as it evolves. For some strange reason, many journalists would still call it a "disease" or a "disorder" in the story or headline,

despite the fact the synesthete interviewed insisted that it is normal. Yet another hurdle we synesthetes have to deal with.

On the flip side, I am a bit disturbed by the path some being taken by so-called "experts", making synesthesia into something that it is not. The wildest claim I encountered was that synesthesia is genetic and "proof" that human DNA was tinkered with by extraterrestrial aliens in some distant past. Others would suggest that synesthesia represent the future of human evolution and this was a result of an evolving brain. I dispute that. Synesthesia had been a part of us since the dawn of humankind. I even believe that, in some ways, it helped in the development of language and music. In fact, I tend to think we all are, in one way or another, synesthetes. Some even went as far to say that synesthetes have "PSI" abilities and may be better at clairvoyance or remote viewing. A synesthete being portrayed as a superior human to non-synesthetes is an exercise in folly. It is a trait, just as eye colors are a trait. Having blue eyes does not make one more superior than the next person. Those pushing these pseudoscientific notions of synesthesia undermine the work of legitimate research, and the spread of such misinformation does no one any good. Fortunately, they are in the minority. Putting out good information is the best counter to such trends of pseudoscience.

Have you ever experimented with your synesthesia with any unexpected, stunning resulting effects? Can your natural or acquired synaesthesia get triggered, reinforced by, or otherwise interact with your deaf hearing? How about vice versa?

Oh yes! I have had some interesting experiences. In my younger days, I relished the thought of going to the dance clubs at New Orleans, dancing to the Techno beats. I loved the club lighting and lasers that would be displayed. I remember, one night, the guy running the lights was doing a terrible job. The syn sounds I was hearing were not matching the music. It was getting incongruent. I even ran up to the DJ booth and started telling the light man what he was doing wrong and, if he does not fix it, I can't be in the room. It was disorientating me. In time, with my input, I improved his performance. As I have



St. Basil Cathedral,
Red Square, Moscow.
Photo: Lidell Simpson

The Spasskaya Tower.
Red Square, Moscow.
Photo: Lidell Simpson

said before, my synesthesias are usually sound based; taste sometimes comes into it. I will relate to the reader my more recent experience that occurred in Moscow. It happened on my last night in Moscow, during my first visit. Red Square at night nearly overwhelmed me. Not only was I was hearing the lights, I started tasting Red Square! GUM tasted of various forms of chocolate! The Kremlin tasted of ginger bread. The towers of the Kremlin and the onion domes of St. Basil were giving me tastes of spearmint, peppermint and wintergreen. In the distance, seeing Hotel Ukraina, the taste of croissant with raisins. I shuddered a bit, wondering what the Muscovites were thinking of me as I walked around Red Square, mouth agape, smacking my lips with flavors as I started to drool. I would not know, since the Muscovites kept on their poker faces, but theirs eyes told me otherwise. On my second visit, a year later, I deliberately avoided Red Square at night. I regretted this. I should have gone. I will make it a point to go back Red Square on my upcoming third visit.

The notion of "Deaf Hearing" never occurred to me, even though I was familiar with Blindsight, until I met Berit Brogaard. Now that I am aware I have this, I can say synesthesia does not connect with this. I have not even taken up the task to "develop" and increase my situational awareness by training myself to expand my deaf hearing. In Brogaard's testing, I was not able to determine the location or direction of the sounds that were below my conscious threshold of hearing. I however was able, better than chance, to guess with my gut instinct the type of sound I was hearing in a forced choice paradigm. I am the second documented case of Deaf Hearing in the world. Her testing went to suggest my deafness may rather be cortical while my ears are intact. fMRI scans revealed that my auditory cortex was smaller and underdeveloped compared to hearing and other deaf people. There is no question in my mind there are cross-connections with the auditory and visual cortices. Deaf Hearing may explain why I do certain things. Often, for some unknown reason, I would turn my head to one side as I was looking at some "phantom" in the room. I may have actually been picking up some sound by deaf hearing and I was responding to it.

It may also explain one experience I had that, to the observer, I would appear to be "Psychic". I was in high school, taking a night class in speed reading. I entered the school and to my left in the hallway was the administration office. The door was open, several people were in the room, and one lady I had never seen before. I assumed she was the speed reading teacher. As I walked by, all I heard was just noise. I could not pick up any words spoken; I simply walked by this cacophony of voices. It was totally meaningless to me. I did note that the woman wore black pants with a white blouse. She had black hair with an olive skin complexion. I sat down in classroom waiting for the teacher to arrive. To my right, I turned to my classmate with the pure intention of just joking and said: "I bet I can tell you the name of the teacher. Her name is Estelle Gunther." "Why?" my classmate responded. I said, "Well, she looked like someone of Spanish/German stock." A few minutes later, she arrived and introduced herself as Estelle Gunther. I was shocked! How, with such *astronomical* odds, did I make such a correct guess? Was I psychic? That disturbed me, since I am a rationalist. For years, it bothered me; how could I have possibly done that? Now I am satisfied that Deaf Hearing was the reason. I had heard that conversation in the office, as Ms. Gunther was being introduced to the school staff, on an unconscious level and it got stored into memory somewhere. When I made that guess, I reached into that unconscious stored memory of that conversation. It was pure instinct.

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James Wannerton:

> Synaesthesia is a truly fascinating condition that is very relevant in today's world; but calling it a Superpower is, in my opinion, a step too far.

James Wannerton was born in Manchester, UK, and was one of the first individuals in the UK to have his synaesthetic experiences studied and documented, appearing in over 100 published research papers world-wide. Wannerton is Vice President of *the International Association of Synaesthetes, Artists and Scientists* (IASAS), President of t*he UK Synaesthesia Association* (UKSA), and is committed to raising the profile and general awareness of synaesthesia via media and art/science projects. He has presented at many international conferences and regularly gives presentations at schools, colleges, National Health Service facilities and other public venues. He has been featured in TV and radio documentaries. Wannerton has recorded educational videos about synaesthesia for the Equality & Human Rights Commission and Wellcome Trust and was instrumental in setting up the National Health Service Choices synaesthesia web-site, which now provides accurate and up-to-date information on synaesthesia into every GP surgery in the UK. His artistic achievements include an award winning *Synaesthesia Garden* exhibited at the 2015 Royal Hampton Court Palace Flower Show and an interactive sound/vision to taste synaesthesia installation at the Victoria and Albert museum. He also has artworks on permanent display at Edinburgh University and the Trapholt Museum of Modern Art in Denmark.

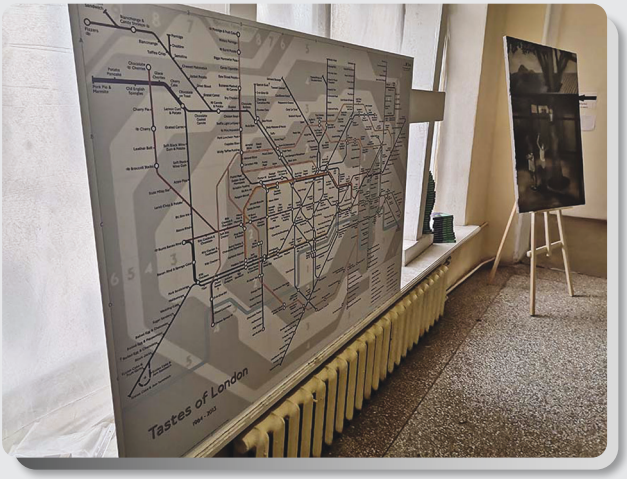
Share how you came to know that you have synaesthesia, your earliest memories about it and how much having synaesthesia influenced your understanding of who you are and what the world is like for you. What roles does synaesthesia play in your life? Does it make you more creative? Are there any other "unusual" thought processes or anything that seems inexplicable in the 'workings' of your mind?

I have experienced automatic and involuntary tastes and textures in response to sound for as long as I can remember. My earliest recollections of this happening were when my mother used to take me on daily journeys to pre-school on the London Underground subway system. I was aged 4 at the time. On these daily tube journeys, I used to read out and write down the names of the stations and their associated flavours as we passed through them. My daily journey was only over three stops, so I began using the tube maps located inside the train carriages to provide me with all the station names further down the line and deeper into the network. The tube train motors themselves also had a taste and texture — that of stewed rhubarb.

At that early age, I didn't realise I perceived the world any differently from anyone else, nor would I have known that the experience had a name. It was just "there" and to me it seemed as normal and natural as breathing. So, as a child, tasting sounds certainly didn't seem unusual or odd. Nor did it cause me any adverse problems that I can remember. For this reason, I didn't talk about it much to anyone outside my immediate family or close circle of friends. As I grew into a young adult and had to deal with young adult situations, this harmonious concordance between myself and my taste synaesthesia altered somewhat. I was aged 15 when the first problems began to surface.

The school curriculum as it was then required annual examinations and I found negotiating those particularly difficult. The exam environment was always the same, a crowd of stressed out students together in a large, echoey assembly hall which only served to amplify all sound.

The exams were always held during the summer months and the windows were wide open, letting in the sounds and smells



James Wannerton, *Tastes of London*, digital print on aluminum, 122×178 cm. The Moscow Conference version exhibited during the IASAS Moscow Synaesthesia Conference at the Tchaikovsky Conservatory in October, 2019. The artwork depicts the author's taste experience in response to hearing the names of all the stations of the London Underground by substituting their actual names with food flavours.
Photo: James Wannerton

A Labour Party poster (100×68 cm, printed on aluminium, 2010) inspired by the synaesthetic sensations of taste James Wannerton experiences in his mouth when he hears different words and sounds; designed as part of a synaesthesia style campaign for the UK's 2010 general election. The tastes James experiences are involuntary and do not reflect his actual political allegiances. Concept by James Wannerton. Photo by Sam Cornwell. Provided by James Wannerton

of summer — birds singing, lawn mowers mowing, children having fun on the school playing fields, …

Within the hall itself, the sound of coughing or the turning of pages, a pencil slowly rolling off a desk and clattering onto the wooden floor, all of these sounds came with a strong taste and texture that caused me distraction issues. Reading the exam questions themselves was also a chore because I found it very challenging to concentrate on the actual questions being asked. All the extra sensory input I'd enjoyed as a child suddenly became a burden. It caused me to panic, which in effect exaggerated the synaesthetic tastes, which in turn served to increase my anxiety.

As my synaesthesia was now causing me obvious and very real difficulties, I began the search for answers as to why. I mentioned it to my parents, who responded by arranging a visit to the family doctor, who suggested it was the product of an over-active imagination and that I would grow out of it. There were even suggestions of attention seeking, which annoyed me somewhat. I clearly remember saying that, if it was attention I was after, I'd choose something more believable than tasting sound. Life went on.

It wasn't until I was 21 that I became aware what I was experiencing was not only known about but it also had a name. I was on holiday in the USA and I happened to catch a TV programme featuring a woman who could see coloured shapes when she listened to music. It wasn't the same type as mine but the mechanics of the process seemed remarkably similar. So began the long journey exploring and discovering more about this thing called synaesthesia.

Learning that I have synaesthesia most definitely altered my outlook from that moment on, and it also explained a great deal about who I was and how I had gotten to where I was. My synaesthesia played (and still plays) a major role in my day to day life. It sits like a mischievous monkey on my shoulder, forever present and making decisions for me, such as who I had as friends or whether I liked a family holiday destination. As an adult, I was attracted to girls who, above all else, had lovely tasting names, and so it went on.

My synaesthesia has made me very aware that everyone is different in some way and, because of that, I think it has made me more tolerant and understanding. It also makes the world around me seem richer and multi-layered and it adds and enhances the lived experience. It's an "additional sense" and, as such, I feel incredibly privileged to have it. Synaesthesia can definitely enable me to become intensely focussed on a subject or task and, in doing so, most likely plays a large part in my own creative process. It can also have the reverse effect and stifle that creative process. If there are too many intense sensory inducers in the mix at the same time, that can lead to a sensory overload or meltdown.

The one thing that has always intrigued me and has never been properly explained is how my brain can fool me into believing I am actually eating something when I'm obviously not. My taste synaesthesia manifest itself as a real mouth feel, complete with taste, texture and temperature. Now that is clever!

What does your synaesthesia tell you about? What can synaesthesia teach others? In other words, what can a synaesthete know about his or her mind, world or art that is not obvious or "open" to non-synaesthetes?

Synaesthesia can teach non-synaesthetes to recognise and understand that everyone is different in some way and, as a result, we can all become more tolerant and accepting of difference in whatever form it takes. It also definitively demonstrates, the more senses that are in operation at the same time, the more you become immersed and part of that lived experience.

How would you describe a perfect synaesthetic situation, and/or an absolute experience or lifestyle that feels most comfortable or resonant with your synaesthesia? What piece of art, setting or situation do you consider most representative of your type(s) of synaesthesia? In general, how often do you feel that your synaesthesia is discordant and concordant with the world "out there"?

As my synaesthesia is particularly intrusive and is the consequence of noise and chaos, the most comfortable situation for me is an environment that has minimal ambient noise, minimal lighting and if possible, a soft warm breeze to round it all off!

I've not seen that many pieces of art that effectively represent my synaesthetic taste experience. The sense of taste isn't a straightforward sensory experience that can easily be recreated in graphic form, or indeed any art form apart from the creation of superbly concordant plates of food, so I have had to create my own art in an attempt to achieve an accurate reconstruction. I do however feel closely connected to the work of Wassily Kandinsky. I am convinced I can see through the abstract and experience what he was experiencing as he worked on his many masterpieces. And, I felt that connection even before I discovered that he experienced synaesthesia himself (https://artuk.org/discover/stories/what-does-a-kandinsky-painting-taste-like).

As regards the question of concordancy, that's a difficult one to answer accurately, so I'll go along with a very concordant 50/50 split. The discordant moments tend to be more immediately noticeable than the concordant ones; but, believe me, the gustatory harmony created by the perfect synaesthetic moment far outweighs any discordant reactions. Those moments are indeed the Jewels in my Synaesthetic Crown.

What was your first encounter with another synaesthete like? Do you understand other varieties of synaesthesia that you do not have? Which would you like to experience (and why)? What type of synaesthesia would you create if you could? What do you think makes synaesthesia a component of art (if you do so)?

My first personal encounter with another synaesthete was a revelation. Gone was the need to attempt to explain the process and it was fantastically refreshing and unique to receive a positive response and an immediate sense of connection and understanding. It was a little like joining a secret society. I cannot extend enough gratitude to the first people I spoke to in this regard: Peter G. Grossenbacher, Sean A. Day, Carol Steen and Jamie Ward (a non-synaesthete researcher), to name

but a few. This was back in the 1990s, when the internet was in its infancy and Google didn't exist, so finding people who understood was very problematic. They also introduced me to the many different types of synaesthesia. The neural mechanics of synaesthesia are the same whatever type you experience; it's simply the consequence of those synaesthetic experiences which are different.

The type of synaesthesia that I would most like to enjoy would be seeing coloured, moving shapes while listening to music. I am so envious of synaesthetes who experience this type and I couldn't begin to imagine what that experience would be like if coupled with my own taste type. Given a choice, I would love a synaesthesia type that embraced all five main standard senses. That would have to be a truly incredible experience.

Synaesthesia has certainly played its part in a multitude of artwork. An artist creates a vision of their own world for all to see and, in my opinion, Kandinsky is the poster boy in this respect. I would have loved to have spoken to him about his creative process and how he managed and used it to such great effect. Knowing the artist's state of mind and going some way to understanding their inner thoughts brings a work of art to life and enhances and enriches the overall enjoyment of the work.

Do you remember any significant life events that may have played roles in developing or reinforcing your synaesthesia? What external factors and conditions are conducive to or hinder your synaesthesia? Have you ever done anything "against" your synaesthesia; for example, suppress it or experience something contrary to your synaesthetic reaction? If yes, what? If no, why?

The most significant life event that reinforced my own synaesthetic experience was most probably the arrival and ready availability of stereo sound via headphones. Music on the whole leaves me with very nice, comforting tastes and textures, so being able to listen to music without any ambient noise distractions made it so much more enjoyable for me. Joy in its purest form.

Other significant events include the creation of my Synaesthesia Tube Map, which in effect gave me a voice to express what I was experiencing in a way that people could relate to. Another would be the time I was called in to the Synaesthesia Research centre at the University of Sussex and Jamie Ward handed me the results of my fMRI scan, which demonstrated conclusively that the brain of a synesthete processed sensory information in a different way to a non-synesthete. That was the perfect example of an Epiphany moment.

Because my synaesthesia is constant and cannot be turned off or turned down, I have to manage and work with it. It's a similar situation found with people suffering from tinnitus. In order to function effectively, they have to learn how to listen around it. Over time, I have developed very effective coping strategies, such as eating strongly flavoured sweets or drinking coffee, which has the effect of supressing it slightly. External factors that induce the most intense synaesthetic reactions are strong smells and loud ambient noise, particularly unexpected, sudden noise.

My relationship with my own synaesthesia isn't so much one of continual conflict but more like a one-sided marriage where one party is constantly compromising and adapting in order to please the other. My synaesthesia doesn't compromise on anything at all, but I do now actually enjoy the challenge of living with such an uncompromising spouse.

How do you feel about the way your synaesthesia, when you share about it, is being received by others? Do you think your synaesthesia isolates or connects you to other people? Could you enhance or use your synaesthesia more extensively in adapting to or transforming the world? Would you, even at the risk of being misunderstood?

The first person I talked to about my synaesthesia was my mother and her reaction was one you would expect from a supportive parent. She has since told me she didn't quite understand what I was talking about but was gentle and supportive with her responses

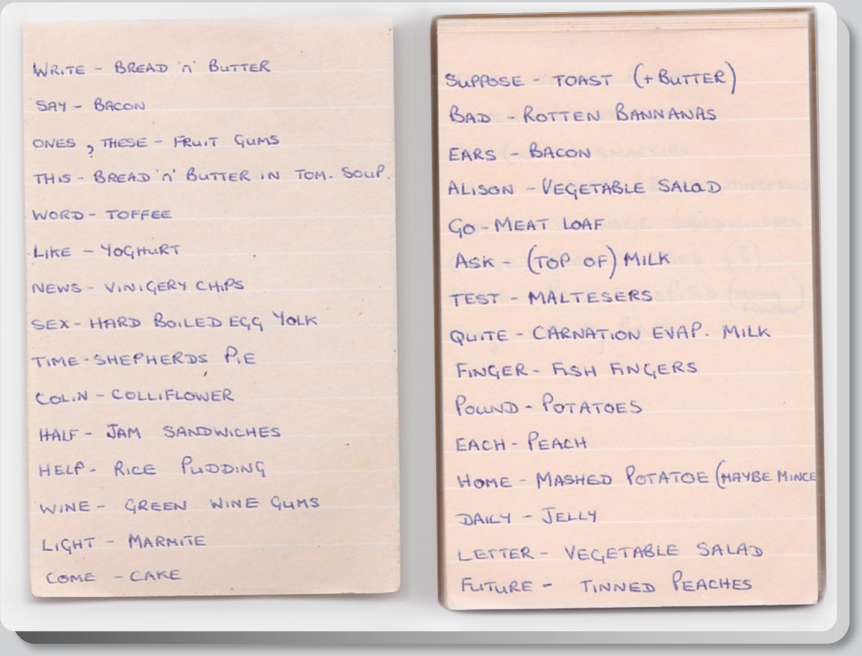
anyway. This seemed acceptable to me at the time, maybe because I believed she understood and possibly even experienced the same thing as I did. The funny thing is, she experiences days of the week in colour! She never recognised and acknowledged her own type of synaesthesia until she was in her 60s.

I also vividly remember discussing it with my very first girlfriend when I was 16. She didn't really understand either but her responses were like my mother's, very gentle and supportive. We actually spent an evening writing down a list of words and their associated synaesthetic tastes in a notebook that I still have. I told some friends at school as well and their reaction was one of ridicule and, to this very day, I still tell them that I made the whole thing up, something which they can accept and deal with a lot more easily than the reality.

I only really began sharing these experiences in detail once I began talking to a neuroscientist researcher under proper laboratory conditions. He provided me with credible scientific backup which gave me the confidence to open up to more and more people. I have never really gone out of my way to talk about my synaesthesia to people anyway, unless it's for research or media purposes or in the unlikely event I'm asked directly. Then, the floodgates open. I have found that my approach certainly didn't make me feel isolated; but neither has it made me feel particularly connected to people, except when talking to fellow synaesthetes of course.

I not sure about being willing or indeed being able to transform the world, but what I think I have achieved is successfully spreading awareness of this truly fascinating trait, and I've raised some valid and important questions regarding the potential similarities and links between synaesthesia and other neuro similar traits such as autism. I'm way beyond the age where changing the world would be a primary consideration and, even if it was, I've been generally misunderstood for the last 40 years anyway, so that certainly wouldn't stop me taking the exact same path all over again.

The most important reason I carry on with my awareness mission after so much time and personal cost is because I know it can and



"I also vividly remember discussing it with my very first girlfriend when I was 16. She didn't really understand either but her responses were like my mother's, very gentle and supportive. We actually spent an evening writing down a list of words and their associated synaesthetic tastes in a notebook that I still have." Pages from the notebook. Provided by James Wannerton

does make a genuine difference for the better in certain individuals' lives, and that reason alone makes it all worthwhile.

Has your synaesthesia ever been scientifically studied? (If yes, share how!) How do you feel about being studied? What would you like to know about synaesthesia that is not yet discovered? What recent discovery about synaesthesia was most revealing to you?

I was the first synaesthete in the UK to have my own particular type of synaesthesia studied, documented and published in accredited

medical journals, and that, alongside the task of trying to convince a sceptical and openly mocking media that this was a genuine experience, has been the most difficult part of the process to deal with. Before linking up with Jamie Ward, I always felt disbelieved to a point where I very nearly convinced myself that this was just some strange trick of the imagination.

Specific studies I have been directly involved with include examining the interaction between synaesthesia and memory, tip of the tongue states, consistency testing, whether synaesthesia diminishes over time and language acquisition in childhood, to name but a few.

One area I think is overripe for further study would include examining some of the down sides connected to synaesthesia. This is an unpopular subject that cuts very little ice with those who find their synaesthesia to be life-enhancing in every way, but it does need pointing out that there are a lot of people out there who find some aspects of their synaesthesia very challenging to live with.

You established the United Kingdom Synesthesia Association (UK-SA). What were your initial thoughts and aspirations behind this? What were the teething problems you encountered? Did the mission turn out as envisioned in the very beginning? What missions should such societies be pursuing today?

The UK Synaesthesia Association (UKSA) was founded in 1989 by Simon Baron-Cohen and John Harrison. Operating as a non-profit organisation, its primary purpose was to connect synaesthesia researchers to synaesthetes. The UKSA's incorporation date of 1989 makes it the longest, continually running Synaesthesia Association of its kind in the world. It celebrated its 25th anniversary at the 2014 UKSA conference in London, at which the keynote speaker was Baron-Cohen, one of its original founders.

I was elected President in 2005 and my first task was to create a working committee, comprised of neuroscientists and synaesthetes, with the aim of collecting together a database of freely available, accurate and reliable information on the subject of synaesthesia for anyone who wanted it.

The UKSA still concentrates on providing that information today, and it acts as a "first port of call" for anyone wishing to find out more about this fascinating neurological trait. On average, we process around 150 to 200 large-scale media or research enquiries per annum, as well as answering up to 400 general enquiries, and we pride ourselves on the fact that we have responded to every single enquiry we have received. The UKSA also supports and promotes synaesthesia and other multi-sensory themed events and research programs from universities, commercial enterprises and individuals from all over the world.

Our remit includes forging closer ties with other like-minded International Associations, the primary aim being the disseminating and sharing of information. We take part in regular collaborations with associations from the USA, Germany, Spain, Italy, China and Australia, to name but a few, and we are presently undergoing a programme helping form active associations in new territories such as India, China, South America, the Middle East, and across the continent of Africa. We are particularly proud of having an active UKSA member on tiny Reunion Island, in the middle of the Indian Ocean.

In the UK, we have developed a good working relationship with the Department of Education and the National Health Service. I give regular talks and presentations on synaesthesia to schools and colleges in an effort to spread awareness and to help create new generations of neuroscientists, essential for continuing future research. As a result of our relationship with the UK National Health Service, every single doctor's surgery in the United Kingdom now has instant access to information about synaesthesia available online or as printable downloads.

We also arrange and organise international conferences, with eminent expert guest speakers from all over the world, with the emphasis on learning about the latest cutting-edge research.

All this activity has not only been useful in spreading awareness of synaesthesia, it has also had a major impact on clearing up the many misconceptions that surround synaesthesia and other related

multi-sensory issues, and I firmly believe the way forward is to discover and nurture these ties to great effect for the benefit of everyone interested in this subject.

I have been closely involved in synaesthesia research since the 1990s and I have seen the numbers grow from a mere handful of people into the multi-national community it is today, and associations such as UKSA have been instrumental in advancing that process.

Over the course of your life, you have encountered quite a lot of pseudoscientific and mystical approaches to synaesthesia. Could you comment further upon the current trends regarding such misconceptions seen on the internet, such as on social media?

Back in the 1990s, in the United Kingdom, there was a glut of scepticism and misconceptions centred around synaesthesia which I believe had the effect of generating serious questions as to the potential value of any future research programmes. This situation then worsened as a consequence of internet-driven misinformation appearing on social media, and, although I am a great advocate of free speech and honest opinion, it is my own personal view that this caused genuine credibility issues at that time and it still causes problems today. For example, I regularly see synaesthesia given the status of a "Superpower", an oft repeated claim by the media, and it has to be said, by a lot of synaesthetes themselves.

Synaesthesia is a truly fascinating condition that is very relevant in today's world; but calling it a Superpower is, in my opinion, a step too far. It is quite simply an advantageous neurological trait endowed on certain individuals, courtesy of the genetic lottery that affects us all. It undoubtably enriches the sensory experience for those lucky enough to experience it but it doesn't come with comic book style connotations.

It has taken a lot of hard work and effort to convince people that this is a genuine trait and having individuals label it a Superpower brings its own unique problems, especially in the UK, where we tend to frown over such claims. I find I spend a lot of my time discouraging any such views in order to minimise the unravelling of all that hard

The Gold Medal winning *Synaesthesia Garden* exhibited at the Royal Hampton Court Palace Flower Show in 2015. This garden is located within a white canvas dome-like tent (yurt) constructed to represent the inside of a synaesthete's mind's eye. The wall surface is washed with different coloured lights in response to trigger words and music, projected onto the inside of the dome echoing the multisensory experiences of a synaesthete. Sculptures and paving materials of glass and mirror enhance the experience of the lighting effects. Designed by Sarah Wilson and James Wannerton. Built by Frogheath Landscapes, DCLX Lighting and Hannah Griffiths Mosaics. Photos by James Wannerton

work and effort. I will refrain from giving real life examples to protect the guilty; but speaking about synaesthesia and specifically named and dubious "Superpowers" such as remote viewing within the body of the same article, with no obvious separation of the two, is incorrect, misleading and harmful.

I myself have suffered the ignominy of being openly named within a published book suggesting that my mission in life was to confuse the senses in much the same way members of the Illuminati do. Although this was vaguely amusing at the time, it did damage my credibility when dealing with the media for a short while following the publication of the book. It has been a long hard road convincing people that synaesthesia is not the product of an over-active imagination or the actions of an attention seeking adolescent, and I will continue to do my very utmost in dispelling such views and opinions, which I think damages our mission of increasing general awareness and understanding of synaesthesia.

Have you ever experimented with your synesthesia with any unexpected, stunning resulting effects? Were there any unusual manifestations of your synaesthetic experience? In general, is there anything about your mind's functioning that still bewilders you?

My lived-in experiences and consequences of my own type of synaesthesia fascinate me and the thing I would like to know more about is how my brain manages to convinces me I am actually eating something when I'm obviously not. The synaesthetic sensations I experience are not associations but real mouthfeel experiences, complete with taste, texture and temperature. It also comes with physical manifestations such as the fact that it directly affects my appetite and often gives me painful stomach aches due to unnecessary and unwanted stomach acid being pumped into my stomach to deal with food that isn't there.

You are a figure with substantial media exposure who has made several appearances in TV episodes, news programmes and public events, especially in the UK. What mission do you

set for yourself in so doing? Can you share the do's and don'ts of talking about the phenomenon of synaesthesia to a layman audience?

I have been lucky enough to have been given the opportunity to talk about synaesthesia in over 50 filmed items and a countless number of other discussions across the entire media platform.

My takeaway from all of these is that the most direct way to gain initial interest and exposure from an audience with a short attention span is to talk about everyday activities and repackage those as experienced through the eyes of a synaesthete. What you certainly don't do is suggest that it's a Superpower!

Neurology, for the most part, is a very dry subject for a layman audience. Add the fact that professionals who have studied the functions of the brain for their entire careers still readily admit to not fully understanding what is going on, and I have found relating lived-in experiences has proved to be a very effective way of getting the message across.

Some of the projects I have been involved in to achieve exposure include: Creating an award-winning synaesthesia garden (and I hate gardening); explaining how I use my synaesthesia to remember things; deconstructing the architecture of familiar tourist attractions into a series of structured flavours and textures; demonstrating how I use my taste synaesthesia to navigate my way around unfamiliar cities and towns; telling people what they taste like and, more importantly, the reasons why they taste that way to me; creating family portraits using items of food to create the composite image; re-examining famous art pieces and deconstructing the synaesthetic structure; and choosing the Car of the Year using just taste perception.

Unsolicited quote from the BBC: *"I've spoken to lots of individuals on the subject of synaesthesia and James is the one who best communicates the intricacies of a fascinating and complex condition in a unique way that anyone can easily relate to"* (Leo Hornak, producer, BBC World Service).

So, I must be doing something right!

Elena Rovenko:

> I believe it is not so critical for a master of the art to have synesthesia. More precisely, all assumptions in this area are not so valuable without an exact factual basis, since a similar result in creativity can be achieved both with the help of synesthesia and without it.

Elena Vladimirovna Rovenko graduated form the Historical and Theoretical Department of the Moscow State Tchaikovsky Conservatory (2010, "Musicology"), Postgraduate diploma (2012). She taught the subject "Polyphony" as a member of the Historical and Theoretical faculty of the Academic Music College at the Moscow State Tchaikovsky Conservatory (2006–2011). Since 2010, her scientific, pedagogical, and creative life is associated with the Conservatory. Currently, she is an Associate Professor of the Department of History of Foreign Music and interfaculty department of Humanities, and senior researcher of the Research Center of the Methodology of Historical Musicology. She teaches "History of foreign music", "History of cinema", "History of arts and problems of modern art studies", conducts elective "Cinema art and specificity of its artistic meaning", and tailors the course "Methodology of Humanities and aesthetic thought: ways of crossing". She is a Candidate of arts (2013), author of 26 articles and a monograph *Time in philosophical and artistic thinking: Henri Bergson, Claude Debussy, Odilon Redon*. Her areas of research interest include French art and philosophy, theory and the history of cinema.

When and how did you find out you have synaesthesia? What were your first memories of it? How much does synaesthesia affect how you realize and understand yourself? Does synaesthesia have any other impact on your life, apart from art and creativity? Is there anything else unusual or complicated that you see in the workings of your mind?

Despite learning about the synesthesia at a very young age, I have been dealing with this phenomenon for as long as I can remember, and my original "synesthetic" perceptions were connected with music. When I was only three, my mother played on the piano and let me listen to records of various compositions from Antonio Vivaldi and Joh. Seb. Bach to Pyotr I. Tchaikovsky and other romantics. I retain my emotions from the pieces of music and the sound of individual notes and chords: sounds that have a certain pitch always "sounded" in color to me. As a person with a perfect pitch, initially, this immediate "sound-color" "bundle" was not recognized by me as a child as something extraordinary, although I do not remember much detail of perception in my childhood.

Another kind of synesthesia — color-grapheme (more associated with the shape of the letters than their pronunciation) — was so natural, and usual for me that I did not notice it. When I heard the sound of C, I was happy about it being "malachite-green" and really beautiful. Thus, "seeing" the letters in color was quite logical for me, and I would be amazed if somebody told me that not all people perceived letters this way. From an early age, I knew that the "ability" of the letters "to appear in color" in front of some "inner eye" can help in memorizing the text. It is even easier to remember the "color" of a word than its meaning; more precisely, the meaning of a word is inseparable from its "color shell". The first letter (I heard this is often the case with synesthetes) gives the word a dominant tone. For example, the word "trait" is vibrant, dark red, because the letter "t" is painted in this color. The remaining letters are superimposed on the "background" tone like a mosaic, set by the first letter. In the word "trait", there is a light green "i", very pale, yellow "r" (about the color of lime honey), blue "t" (close to dark indigo), white "a".

If I remember a deep red and blue word, I can remember the word in a context like "trait" or "drawing", for example. Numbers with "color" help in remembering phone numbers, important dates, etc. I think this is nothing special, and most synesthetes use their synesthesia for the development of, let's say, personal mnemonics.

Perhaps I will not be able to tell much about the obscure in the workings of my mind. Actually, I cannot consider synesthesia as something unusual. I got too used to it. There are exciting effects associated with people's names. In particular, each person is felt by me, so to speak, in a halo of a certain tone, depending on the color of the name. For example, a person named Gregory will have, metaphorically, a brown "aura"; Christina, blue; Vera, reddish; Lyudmila, pale pink; Natalia, dark green; etc. Of course, the "coloring" of the name, in any case, does not affect my attitude; but it leads to developing a certain sense of a person — not as a person but as a "carrier of color".

Synesthesia affects the activities associated with writing texts rather than my life, although this influence comes from childhood, and therefore I feel it only if I think about it. When I write texts, I sometimes replace some words that allow synonyms with words more "attractive" in color, more "pleasant" for the words' neighbors (because the words standing next to each other "shine" and "interact", you can even say "reflect", on each other). For example, "perhaps" (reddish-yellow) itself is somewhat nicer than "maybe" (yellow + dark brown). But the word "blue" (on the letter "t" or "K") calls for the second-mentioned construction because the shade of red in the word "perhaps" does not combine harmoniously with blue. Of course, such moments are not thought out specifically, but rather arise intuitively.

What is the meaning of synaesthesia for you? What can synaesthesia teach others? In other words, what can synaesthetes know about their inner world, the world around them, or creativity that may not be obvious, or even "hidden" from non-synaesthetes?

These are hard questions. I believe that, in principle, synesthesia can teach a more refined perception of the world (the surrounding reality

and the reality of the soul). I guess I'm thinking like an art critic. At the time, I believed that synesthesia is, in some way, consonant with the search for a synthesis of the arts based on the essential correspondences of their expressive means and the qualities of the artistic material with which these arts operate. I would like to put a particular emphasis on the word "quality". If we recall the concept of "correspondences" by S. Baudelaire ("Les correspondances"), by which we mean the "roll call" of the qualities of objects of the surrounding world; that is, colors, sounds, properties of texture, the very matter of which objects are composed. It is clear that this perception of the world, through the prism of "roll call" of different qualities, firstly allows you to grasp the connection between objects, and secondly to perceive each phenomenon of reality more "volumetrically", and in the diversity of all its qualities, and even give (better to say assign with the help of intensive work of consciousness) some properties that were not originally inherent in it.

In my opinion, synesthesia supports both of these processes. Thus, the connections between phenomena are mainly due to the "color" of their language equivalents for me. Names of objects with similar "color" intensively correlate (as a kind of "compositional rhymes" in the text of the world), "contrasting" names antagonistically "push away" or, on the contrary, "strengthen" the "sound" of each other. For example, words beginning with "blue" letters (different shades and intensity: 'c', 's', 't'; for example, "cat", "shelf", "tone"), when put together, "color" the entire phrase in a bluish dominant tone. In the "aura" of this tone, phenomena, indicated by the appropriate words, appear in my mind. There is also a reverse effect: ordinary objects "bear the imprint" of the "coloring" of their name. Hence, when put together, they form a "coloristic" ensemble, through the prism of verbal thinking, of course. This effect is hard to explain. It might look strange from the outside, but the sofa, for example, is always presented in a slightly brownish, chocolate-colored, "transparent" halo, regardless of the color of the upholstery. Therefore, a dark brown "sofa" and a light blue "chair" coexist more harmoniously than a "sofa" and a lilac-purple "chair". I believe this is because synesthetic effects in my case are "superimposed" on the specifics of verbalization because, on

the one hand, I am a visual person. On the other hand, I am used to living among texts, and in general, a European person cannot live without a language.

How would you describe a perfect piece of "synaesthetic" art or an event from a life experience that perfectly matched and agreed with your synaesthesia?

In my opinion, it is more logical to discuss not the perfect work of "synesthetic" art, but rather the ideal perception of works of art, which, perhaps, could be possessed by a person with multi-synesthesia, with "bridges" between all the senses in the consciousness. However, I cannot even imagine such a "volume" of synesthesia and the life of a person with it. After all, any sound, word, smell, color, etc. would cause a whole firework of joint representations, which would go in intricate "counterpoint" with the phenomena of the surrounding world, in the complex of their really perceived qualities.

As for life experience, I rather had negative examples. Thus, my acquaintance with attempts of teachers-musicians "to awaken" tactile, olfactory, gustatory reactions to harmonies of a particular structure did not cause sympathy in me personally. I can force myself to build some association that will "work" for a while to "recognize" certain chords by ear. But this coercive act has always seemed to me to be a violation of natural auditory perception. The colors of the components occur when listening to them involuntarily, so I will "see" the chord in a specific color regardless of any conditions. The association created by an effort of will cannot replace natural synesthesia.

What was your first encounter with other synaesthetes? Do you understand different forms of synaesthesia that you do not have? Which one would you like to experience? If you could, what kind of synaesthesia would you like to create? What do you think makes synaesthesia a part of art? Do you suspect synesthesia in any creative people, if it is not known whether they were synaesthetes or not?

The first synesthete among the people I know is my mother, with "colored hearing". Later, I encountered other musician-synesthetes,

at the music college, then at the Moscow Conservatory. All the synesthetes I knew had grapheme-color synesthesia, and some of them had colored hearing.

At the same time, a synesthesia of another type, which is not connected with bright color representations, is, of course, understandable to me, but mostly rationally. In other words, I do not believe that synesthesia can be "understood" "from the outside", as I feel that to understand is to experience comprehensively, rationally, and sensually. I can imagine that, say, a small seventh chord with a reduced fifth might appear so "sour" to some that it will evoke the taste of lemon in the mouth due to its tense, not overly sharp sound. Although I cannot experience this effect on myself and my representation will be speculative. I am more likely to be able to recreate a chain of individual associations for myself that will make the synesthetic reactions of another person clearer to me. And yet, the association is not synesthesia.

I am not sure about other types of synesthesia. Perhaps, I would like to experience smells and tastes when listening to music. But, as for grapheme-color synesthesia, I have enough of it. I think it would be hard to perceive the text (and, in general, to exist inside the language) if, in addition to color, in response to letters or words, feelings of texture, taste, or smell would be awakened. However, a type of synesthesia I would really like to "create" in myself — I would like the color in my mind to cause not only graphemes or sounds of a certain pitch, but also smells and tastes.

I cannot perceive synesthesia as a part of art. To me, it is a way of understanding the world, "communicating" with it. Synesthesia can be integrated into the creative process, as Scriabin or Messiaen did; but, in my opinion, it cannot be part of their works as such. I believe it is not so critical for a master of the art to have synesthesia. More precisely, all assumptions in this area are not so valuable without an exact factual basis, since a similar result in creativity can be achieved both with the help of synesthesia and without it.

For example, Vincent van Gogh was considered by some to be a synesthete because, according to his own statements, he intended

to achieve a particular effect when working on Potato Eaters. The observer was supposed to sense the weight of potatoes, the aroma of the pork, the scent of smoke. For this reason, van Gogh was looking for the earthy, brown, and dark blue colors associated with the color of the earth and roots; he used broad strokes, protruding above the surface of the canvas. Such a pasty texture should have caused a feeling of heaviness. Of course, the reactions will occur according to the algorithm of associations; such an intense and absolutely direct psychophysical effect of colors on consciousness is hardly possible. For van Gogh himself, as it turned out in the end, the selection of colors (tone, saturation, chemical composition, and physical properties of the coloring substance density, friability, oiliness, etc.) was the subject of conscious calculation, instead of intuitive, creative inspiration. Van Gogh did not have synesthesia.

Here is another example. From the memoirs of George Sand, we know that Frédéric Chopin improvised his prelude Op. 45 under the impression of the theory of reflexes, outlined by Eugène Delacroix in conversation with the composer. The Prelude is saturated with modulations, and all the chords appearing in the prelude as local tonics line up in a nearly complete chromatic scale (only one sound is missing). Some researchers, such as Jean-Jacques Eigeldinger, for instance, attempted to match the acoustic tones of the chords and colors from the chromatic circle of Michel Eugène Chevreul. I tried to assign each key a color so that the colors of the various keys were different. But I could not find colors to meet my understanding: the computer palette was too rough. The result is a tonal plan of the prelude, presented as a variation of different colors, similar to a kaleidoscope.

Perhaps Chopin really sensed the "color of the chord", and, having constructed the modulation plan of the prelude so that 11 of the 12 possible tonics were included (without distinction of major and minor, but, in two cases, with enharmonic replacements), he intuitively conformed to the "coloristic" variety of the sound. However, feelings of "different colors" of the chords does not guarantee that Chopin had a "colored hearing", since the metaphorical concept of "color" could

just imply a qualitative difference in the sound, which can be described with adjectives (e.g., "brighter" sounding chords in the higher register).

How would you describe a perfect, absolutely synaesthetic lifestyle or situation that would come into absolute resonance with your synaesthesia without the slightest contradiction? Which work of art, setting, or situation could serve as a perfect illustration of the varieties of synaesthesia you possess? In general, how often do you experience situations that are in dissonance or resonate positively with your synaesthetic experiences?

Perhaps, an all-consuming rather than a perfect synesthetic way of life assumes a variety of synesthetic "bridges" and reactions. Maybe, it also means all possible "links" between all the qualities of objects in the complex. In this case, each shade will be in accordance with a specific aroma, taste, tactile sense, sound of a particular timbre, height, dynamics. But can such a sense of the world be called perfect (even from the point of view of synesthesia)? Will it not be excessive on consciousness? Will it not be overly deterministic and lead to all properties of objects evoking programmed reactions? Will such a sensation exhaust the spontaneity and variety of human reactions and lead to psychic reality, endangered by ignoring the world around? It seems to me that the perfect synesthetic lifestyle implies the presence of synesthesia that would be harmoniously combined with the non-synesthetic perception of the world (for example, grapheme-color synesthesia is linked with non-synesthetic perceptions of smells and tastes).

It is hard to say which work of art or setting would be the perfect embodiment of my synesthesia, as my synesthesia does not necessarily exist in the context of art. It merely accompanies my life with a counterpoint. All sounds of music, any written text, cause color perception, and experiences. Therefore, I cannot think of a situation that would be more or less favorable for my synesthesia.

Did anything in life cause the appearance and development of your synaesthesia? What external factors and conditions

contribute to or suppress your synaesthetic sensations? Have you tried to do anything "against" your synaesthetic reactions, for example, suppress their manifestation or try to react against them?

I don't think any events have really affected my synesthesia. It appeared at a very early age when I learned to read, because the color for me is associated with graphemes rather than the sound of the words. However, perhaps, the brain has some prerequisites for creating appropriate "bridges" between the outlines of letters and colors. No external factors and conditions affect my synesthesia: it occurs in any situation. In this case, the letters I see are slightly brighter and more intense in color than those that I can imagine. My color representations do not conflict with the real (perceived by the eye) color of objects at all. For example, if I see number 5 written on the train carriage drawn with red paint, it does not prevent me from seeing "5" in blue. These two perceptions are not "superimposed" on each other, but exist independently. If there is a dark maroon cherry on a plate in front of me, the word "cherry" does not cease to be reddish, with "notes" of whitish-gray, dark violet, green, and scarlet. Therefore, I never felt the need to suppress my synesthetic reactions.

How do people around you perceive your synaesthesia? Do you believe synaesthesia separates you from others or helps you interact with them? Do you have the opportunity and desire to use synaesthesia in your work more extensively?

I can honestly say that, up to this point, very few people were interested in my synesthesia, except for the synesthetes I met. And mostly, they just wanted to compare our perceptions. Since most of the synesthetes I met were musicians, we mainly discussed the "color" of certain sounds, keys, and chords. My mother and I or fellow students could review the saturation, luminosity, brightness, transparency of a color that correlated with the same pitch or tonality in them and in me. Or how loud and intoned should a note be — "La", for example — to evoke its representation not as a pure blue sound, but bright or matte blue, or pale-pearl or transparent; how the way

of deriving a sound affects the perception of music "in color" (for example, the sound played legato seems richer and more vivid to me than staccato or pizzicato on the strings). However, I do not experience a change in the quality of the "color" reactions when changing the sound parameters. For me, "sounding", "audible", color is primarily the pitch of the sound; conversely, a "colored" tone is a sound of a certain pitch, and its loudness, timbre, and manner of production are secondary.

All the non-synesthetes I met either shrugged their shoulders when they heard about synesthesia or did not react at all, leaving the more knowledgeable people to communicate on this topic. Therefore, my synesthesia has never caused me discomfort, nor has it promoted particular closeness even with synesthetes. After all, I always learned about the synesthetic abilities of a person after we began to communicate, being friends, or cooperate.

I guess, if I were an artist or a composer, it would be tempting to put my synesthesia into practice and create, for instance, a picture where the colors would correspond to the sound of some musical piece. However, I do not believe that synesthesia can be applied "on request", nor that synesthetic experiences can be induced by some invented "techniques".

You surely have some favorite pieces of music and authors that are especially close to you. Could you describe in detail your synaesthetic experiences that accompany listening to them and possibly explain their aesthetic appeal?

Oddly enough, the aesthetic appeal of my favorite pieces of music is somewhat indirectly related to my synesthesia. For example, I love music by Claude Debussy. Still, the aesthetic and exact auditory pleasure from listening to his works is delivered to me by the general phonic impression. It stems from the structure of the chords, selected by Debussy, and the logic of their "neighboring"; timbre plays a considerable role in shaping the auditory impression. I like "how it sounds", not "how it's colored". Although it is "colored" very attractively: the specificity of Debussy's musical language is such that

it is perceived like a kaleidoscope of pure colors immersed in a smoky haze, as in the paintings of Claude Monet or William Turner, loved by the composer.

Each sound has its own color, and since Debussy's' consonances often consist of non-repeating sounds (without octave duplications), they turn out to be multicolored. The leading tone of the chord (if it is heard clearly) can give some general color (like "background" for more clearly "visible" colors corresponding to individual sounds). In general, all the tones that form consonances in Debussy's music, as well as the sequence of consonances, create a kind of veil in my perception, mottled with spots of all colors and shades.

However, the works of different eras have their own characteristics of "coloring". If we are talking about the functional harmony of the classic era, the "color" of the tonic of a particular tonality is essential here; sometimes, the attractiveness of color to me determines a special love for the work. So, as a child, I loved playing Wolfgang Amadeus Mozart's and Joseph Haydn's keyboard sonatas in D major because of their bright golden color. The C major sonatas of "peach color" had less impression on me. However, in Renaissance culture with its different fret (modal) system, the specificity of its sound outside of any "coloring" rather than general "coloring" of the fret, its "dominant tone" was vital for me. For example, I am very fond of compositions in the so-called Phrygian fret (in the Renaissance interpretation), because of its strict and gloomy sound due to the second low stage of the fret. But whether it is "white" (if the final note is "mi") or "blue" (final "la") — for me, it does not matter.

And another nuance: I lean towards works with the leading (central) "si" tone (tonic, depending on the fret system). This is my favorite sound in terms of "color": velvety-malachite, thick, and rich; and the work itself can belong to any era (for example, the first chorus "Kyrie Eleison" from the Mass in b minor by Joh. Seb. Bach; clavier sonata by Domenico Scarlatti; piano sonata by Alban Berg). This is the case when synesthesia directly affects the pleasure of listening. It is noteworthy that my favorite color is not malachite or another

shade of green, but bluish-ultramarine. I cannot explain this strange mismatch of preferences in any way, as, if my favorite sound corresponded to my favorite color, it would be not "si" but "la".

Why do you think you chose musicology, a theoretical and historical field, rather than performing arts? In general, how did the fact that you have synaesthesia affect your life choices? How directly or indirectly did it determined the formation of your professionalism and the direction of personal development?

My choice of musicology was not due to my synesthesia but my penchant for the philosophy of art. It seemed to me that, to understand the development of art, one needs to know the history of painting, architecture, literature, and theatre, in addition to the theory and history of music, and this demands professional education in the relevant specialty.

Synesthesia has positively affected one aspect of my life: my irresistible craving for the visual arts. If I had the chance and time, I would try myself to draw. But I can't imagine life without visiting exhibitions and museums. Still, I am a visual by nature, and it is constant visual impressions of an aesthetic nature, associated with art, that I need like air, to a degree no less than the actual musical ones. I would say so. I have enough visual impressions in my everyday life. However, when you "see" and "hear" the objects around and all the letters in color, you subconsciously want the transition of this "quantity" in another, highly artistic "quality". This quality can be provided by fine art.

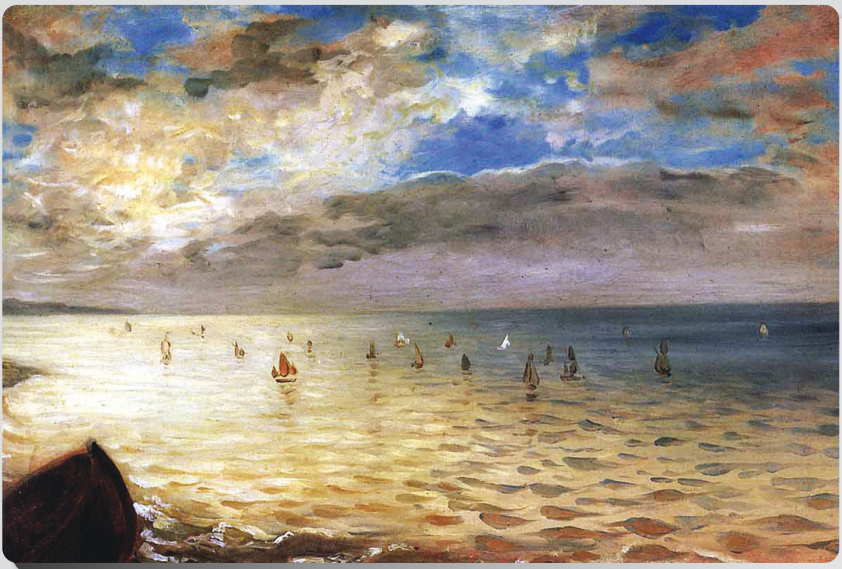
How are the separate musical and acoustic units from other, non-European, sound orders, tones of other interval systems, perceived in synaesthetic color? How do you perceive melodic structures synaesthetically in the case of glissandos?

To be honest, for me, the non-European music remains "alien". I did not get used to it. I can force myself to listen and analyze; but, so far, I cannot get pleasure from such listening—auditory, not intellectual, or aesthetic. Music, which includes, for example, quartertones, and especially microtonal music, requires a significant effort from me, and here we can discuss just a sonic haze, rather than the "color" view.

cis-D-Es-Ee-F-fis-/Ges/G-As-A-B-Hh-/Ces/.... [C]

cis	H	h	A	fis	D	G	D	fis	E	e	B	Es	Ges	Ces	Ges	Es	As	F	cis	H	h	A	Cadenza	cis	D	cis

The scheme represents the key and harmonic development of Frédéric Chopin's Prelude in C-sharp minor, Op.45, presented as colour equivalents. While developing its modulation, each new tonality of the piece acquires correspondence to a certain colour. The scheme is designed to demonstrate that the key and harmonic aspects span across almost all the twelve sections of the chromatic scale as the scale degrees. Specifically, this means that, the major and minor destinction aside, within a particular section of the scale can be made a key with the main scale degrees corresponding to the given section of the scale. This span that encopasses almost all the sections nearly measures up to Chevreul's chromatic diagram that Delacroix used to refer to. Created by Elena Rovenko



Eugène Delacroix, *The sea in Dieppe*, 1852. Cardboard on wood, 35×51 cm, Musée du Louvre, Paris. Public domain

Nevertheless, my synesthesia is related to a musical upbringing in the European culture of a particular type and historical period. For a clear color representation, a sound that is sufficiently defined in height is sufficient for me (of course, taking into account the zoned nature of hearing), which does not "slip", but passes into the close sound, and the step of such a transition should be at least a semitone. If there is a "slip", the color will not occur until a certain pitch appears. If this pitch is "in" the usual diapason (the first octave A is 440 Hz in the modern tuning), my hearing is likely to "pull" this pitch to the nearest familiar (taking into account the direction of movement of musical matter and possibly gravity). Listening to music like, say, the opening of a *Book for orchestra* by Witold Lutosławski (not to mention the *Threnody* by Krzysztof Penderecki), the quartertone "sliding" of the strings is perceived as a haze without specific color, like fast and colorful change of all colors of the rainbow. It is a pity, of course, that my synesthesia does not allow for "quartertone differentiation"; otherwise, my palette might have been more nuanced.

You are talking about "sounding", "audible" color. How do reactions of this kind differ in quality and mechanics from the music "visible" in color? Are these experiences "reciprocal"—that is, with a systemic (mirror) correspondence?

Not at all reciprocal, and I know that I will not reinvent the wheel with this judgment. Like many other synesthete musicians, I "see" sounds (or letters) in color "by themselves"; I do not need to make any effort for the act of such a vision. These reactions are involuntary and not controlled consciously. As for the "audible" color, it is a different type of process. A particular color (or color scheme) can make me experience a specific pitch (or tonality), and sometimes a timbre. For example, Delacroix's late landscapes, in muted bluish-grayish tones, often appear as A flat major.

As we know, Wassily Kandinsky, in his treatise *On the spiritual in art*, declared congruences between timbre, pitch, and a specific color. For example, he was convinced that bright yellow cannot be associated with the sounds of low register and that the timbre of the trumpet

was the most suitable to reflect the essence of yellow. On the one hand, Kandinsky could be right, although I cannot justify it by appealing to a scientific basis.

No wonder, in the Baroque era, D major, for example (golden, in my view), was honored as a triumphal, Regal key, and was used in church and opera culture to materialize the categories of glory, greatness, and victory and often assumed the use of trumpets and timpani. On the other hand, I knew a man who considered D major as dark blue, "the color of the night" in his "palette". The harps and, say, the gloomy English horn going in the "darkened", middle register, would be highly appropriate here. Besides, D major can be simply yellow, not just golden (I also know a person with similar synesthetic experiences). For such "calm" yellow, the timbre of the trumpet is excessively brilliant and sharp. In other words, not everything is clear "from the color's point of view" in establishing correlations between the sound and the color (and their characteristics).

In your work "Time in philosophical and artistic thinking", you reflect on Henri Bergson's idea of color as a self-sufficient entity, taken outside the "serving to the form" — a "spiritual color" (*la couleur morale*). In your opinion, to what extent can a color, perceived synaesthetically, echo Bergson's idea of dematerialized color? How do you think Bergson himself would interpret synaesthesia, if the philosopher had direct "access" to experiences, similar to yours?

I am not sure about Bergson: I would not like to assign someone else's words to the philosopher. As far as the "spiritual color" is concerned, I can only make a philosophical and metaphysical rather than scientific assumption (after all, Bergson is a philosopher, to begin with). The perception of color as "sounding" or "fragrant" may seem to "give" it all imaginable ranges of characteristics, inconceivable for the usual depiction of reality. In this sense, the color becomes spiritual — not metaphysically, of course, but in the aspect of the uniqueness of its complex being in the consciousness of the person ("moral" is not only "spiritual", but also "mental"). Indeed, when I hear the "violet" sound

"fa", for instance, this violet color in my mind does not belong to any object; it appears before my eyes as if "by itself". In principle, this perception is quite close to the understanding of dematerialized color, which Bergson wrote about (in this case, such a color really "lasts" partly because it corresponds to a particular sound—and therefore can really be perceived partly as the equivalent of Bergson's la durée).

Timothy B. Layden:

> Through my investigations into my own synaesthetic experience as an artist, I discovered more about myself than I could have by merely thinking about my sensory experiences.

Timothy B. Layden is a visual artist, musician, writer and art educator. Born in Seattle, Washington, USA, he has worked in the USA, Mexico, Italy, Japan, Spain and the UK. He received a B.A. in Fine Arts from the University of the Americas in Mexico, Puebla, Mexico, in 1995, and a Doctorate in Fine Arts with research on interdisciplinary arts and synaesthesia at the University of Barcelona, Spain, in 2005. In Mexico, he co-formed his first collective with young international artists and worked with local youth in cooperative art projects. From 1995 to 1997, he produced mixed media work and ran workshops from his live-in studio in Seattle, USA. In 1997, he worked with marginalized youth, graffiti and fine artists to develop murals for the City of Seattle. In 1998 and 1999, he lived in Japan, where he helped form the art collective Club Ikebukero. From 1998 to 2000, he travelled from Japan to Mexico and to the US, working with different artists, creating and exhibiting. In Spain, while doing his Ph.D., he developed a series of exhibitions and worked with a street theatre group. Currently, he works in England as a teacher and an artist, developing projects related to art, science and synaesthesia as an active member of the *Artecittà Foundation*, the *UK Synaesthesia Association* and the IASAS.

Share how you came to know that you have synaesthesia, your earliest memories about it and how much having synaesthesia influenced your understanding of who you are and your creativity. Does synaesthesia play other roles in your life besides art-making and creativity? Are there any other "unusual" thought processes or anything that seems inexplicable in the 'workings' of your mind?

My strongest early memories of synaesthetic experiences are those related to sound. One of my favourite of these is when I heard a trumpet being played live in front of me for the first time. I must have been about seven or eight. I was at school and one of the older students came out of the music room blowing a trumpet as loudly as he could. A single harsh note enveloped me in a burst of jagged lines and warm colours. I later went on to play the trumpet myself, as well as other musical instruments. I often use my synaesthetic experiences of sound, primarily shape and texture, to dictate how I play. Experiences like that of the trumpet, where my synaesthetic responses overwhelm me, stand out in my mind. I can recall occasions where sound shapes appeared so vividly that I spent moments after they had disappeared looking for where they went. I remember always seeing the world within my synaesthetic perspective; sound has always appeared to me as moving shapes and textures that carry a sense of colour with them.

I did not discover the term synaesthesia until my twenties, when a friend of mine discovered the term in one of his girlfriend's textbooks on psychology. We talked about it at a party and I quickly recognised that the term described something I personally experienced. After discovering the term synaesthesia, I went on to read some of the research that had been done on the subject. I eventually discovered *The Man who Tasted Shapes*, by Richard E. Cytowic, and *Speak, Memory*, by Vladimir Nabokov. These helped me comprehend some of the basic theories behind synaesthesia as well as its subjective underpinnings.

As a postgraduate student of fine art, I went on to research the influence of non-visual experience on modern and contemporary visual art, as well as the potential implications of synaesthesia in the

creative process of particular artists as well as towards the creative process in general. In addition to theoretical research, I undertook a personal investigation into my own experiences of synaesthesia, which I translated into sound and visual artwork. This work, although still prominent in my artistic practice, culminated in a post-doctoral art project titled *The Shape of Sounds* (theshapeofsounds.com).

Through my investigations into my own synaesthetic experience as an artist, I discovered more about myself than I could have by merely thinking about my sensory experiences. My process of investigation involved not only thinking about what I was experiencing but capturing the sensory input that caused specific synaesthetic responses. This was done by recording and then listening to specific sounds repeatedly to document different aspects of my experience through drawing, painting and writing.

To begin with, the synaesthetic experiences I chose to use as inspiration for my work were quite strong. Through the process of observation and experimentation, they became even more detailed and vivid; at times, sounds appeared to be almost convincingly solid. I wondered what my brain was doing and why I had these experiences. I noticed that my synaesthetic responses to sound were most vivid when I could not see the source of the sound, whether I knew what the original source was or not. I wondered if it was therefore my brain attempting to create a connection between the physical world and the invisible sounds around me by creating visual perceptions for the sounds. This brought forward other aspects of my mental processes in relation to imagination: abstract concepts in general have a certain shape, colour and texture; things such as emotions, events and places appear in my mind with particular shapes, colours, textures and forms that feel right to me—these are different from my experience of sounds, as they exist within me as part of my imagination rather than externally as the shapes of sounds do.

What does your synaesthesia tell you about? What can synaesthesia teach others? In other words, what can a synaesthete know about his or her mind, world or art that is not obvious or "open" to non-synaesthetes?

From my understanding, synaesthesia is the product of particular kinds of neurological make ups that routinely behave in manners resulting in coupling or multiplying sensory information, causing a blending of senses. In my case, I sense sound in a way that is not only aural but also spatial, kinaesthetic and visual. I also sense abstract concepts beyond their simple names and common associations with a sense of shape, colour and form that is possibly related to unconscious emotive experiences.

Synaesthesia may have the potential to teach us more about how ideas and concepts are formed at a very basic level. It may also give insight into how the human mind, as well as that of other intelligent animals, uses conceptual building blocks in creative acts and problem solving. Further to this, synaesthesia may show us the structures of personality, identity and even prejudice. Research into human experiences such as synaesthesia can highlight the importance of examining different kinds of perception and broadening our understanding of the rich variety of ways in which reality can be perceived.

People with synaesthesia very often experience things that seem quite obvious but may seem obscure or even absurd to others. While saying this, when synaesthetes share their experiences with others, a new understanding can emerge that can open minds to other ways of perceiving and understanding. This may in turn bring us to re-examine the world in new ways.

How would you describe a perfect piece of synaesthetic art, or an absolute experience or lifestyle that feels most comfortable or resonant with your synaesthesia?

For an artwork to have its strongest effect, the knowledge and experience of the artists needs to link somehow to that of whoever is experiencing it. Keeping this in mind, the artwork that I enjoy most, that which is closest to perfect for me, is that which is done with experience and trained skill as honestly as an artist is able.

Considering the above in regards to 'synaesthtic art', I feel that the most successful work of this kind is done by artists who are themselves synaesthetes. I say this as I have worked closely with artists who

are not themselves synaesthetes, yet have attempted to represent the experience of synaesthesia based solely on the accounts of others. My experience of their work has often been dissatisfying. On the other hand, close collaborations between skilful artists and synaesthetes can result in powerfully effective artwork: the photographic work done in collaboration between the taste to sound synaesthete James Wannerton and the photographer Dominic Davies creates intriguing conversation pieces for discussing synaesthesia. Synaesthetic art can be very powerful when the viewer is asked to participate directly with the art and therefore experience a little of the artist's synaesthesia: Christine Söffing creates interactive work that invites others to play with the shapes she experiences for sound by walking within them, feeling and hearing them. At the same time, such direct interaction is not fundamental for a participant in art to be affected. If an artist can create such a compelling image that the viewer is drawn into it and spends time examining it, the story behind the work can allow the viewers to let their thoughts run closer to the perceptions of the artist: the paintings of Pepa Salas Vilar, who experiences personality to colour synaesthesia, contrasts black and white images of people with the vivid colourful abstract shapes that sit outside the figures like photisms, immediately grabbing the attention of the viewer and bringing them into the visual relationships.

What was your first encounter with another synaesthete like? Do you understand other varieties of synaesthesia that you do not have? Which would you like to experience (and why)? What type of synaesthesia would you create if you could? What do you think makes synaesthesia a component of art?

It wasn't until my thirties that I found myself in a friendship with another synaesthete that had similar experiences to my own and was happy to indulge in conversations about them. This was amazing. It was like I had found a lost sibling. Most often when I get together with other synaesthetes, I feel like I am with family in the way that I am with people who share things with me that few others I know understand. I love hearing about the variety of different ways other

synaesthetes experience the world differently to me. I do not have sound to taste synaesthesia, though through the many conversations I have had with James Wannerton, I have begun to understand a little of how he experiences it. By hearing or reading about the experiences of others that differ from my own, I begin to understand my experiences more and see things in them that I did not earlier perceive.

One form of synaesthesia that I do not experience that I would like to, although it frightens me, is mirror touch synaesthesia. At times, I wish my concept to colour shape synaesthesia were more vivid. I would like to be able to have the shapes in front of me like objects that would not distort or fade when other things distract me and be able to actually grasp them in my hands to examine them slowly from all sides.

What piece of your art do you consider most influenced by or representative of your synaesthesia? Do you remember how you created it? What other artists not known to have synaesthesia do you feel were nevertheless synaesthetes? Why?

I created a series of artworks that dominated my life from about 2008 to 2010. This was *The Shape of Sounds* series. It consists of 11 soundscapes, around 100 initial sketches, 11 watercolour paintings and 11 oil paintings. I initiated the project as what I told myself was a synaesthesia safari, wherein I hunted for prominent sound shapes, capturing them with a sound recording device and then documenting them on paper, much in the way a scientific artist the likes of Ernst Haeckel might record a newly discovered species of jelly fish. From these initial drawings, I developed a series of compositions of visual soundscapes in watercolour sketches that I finalised in larger oil paintings, creating a sort of menagerie of my sound shape synaesthesia. The "shape of sounds" series was long and immersive in a way that no other project I have worked on has been. It changed my whole perspective of my own experience. I learned to analyse my perceptions with more observational skill while creating an arsenal of visual art that I could use for exhibitions and discussions around the subject of synaesthesia.

František Kupka is one of my favourite artists of the 20th century. His work had a major influence on the abstract art movement. Whether he

had any form of synaesthesia or not, I do not know, though I do feel his work touches a chord between the senses. One contemporary artist whose work reflects that of Kupka's is Julie Mehretu. Within the abstract expressionist movement, the potential for creating imagery to represent non-visual experience is tapped through experimentation and freedom of form that can often bring in natural organic looking forms which often fail to surface from more deliberate forms of visual representation. My own experience of synaesthesia is filled with these types of seemingly accidental organic forms and what I love about much abstract expressionist painting is how I can find sound shapes within them.

Do you remember any significant life events that may have played roles in developing or reinforcing your synaesthesia? What external factors and conditions are conducive to or hinder your synaesthesia? Have you ever done anything "against" your synaesthesia; for example, suppress it or experience something contrary to your synaesthetic reaction? If yes, what? If no, why?

I remember from a very early age enjoying describing my world to others, combining what felt to me to be the real world with an imagined one. My parents and their friends encouraged the side of my character that liked to describe my observations and play with imagination as well as describing the details of my sensory perceptions. As I became older, I was encouraged to read, play music and do art. I was described as being very creative and imaginative. My experience of synaesthesia became intertwined with my imagination and artistic expression. At times, the lines between what I imagined and I truly experienced would become blurred and it was hard for me to tell what was really happening.

I left home at sixteen to live in Mexico, where I studied art. I fell in love with how art can play with reality, how Mexican folk art and surrealism seemed to be almost magical. Though the magical realism and surrealism of life and art in Latin America opened my mind to many things, it also confused my understanding of myself. When I began

painting, surrealist themes merged with the shapes found in my synaesthesia. It was only after I discovered the term 'synaesthesia' and began investigating it as a neurological condition that I began to disentangle my dream world of magical realism from my sensory perceptions.

Due to my involvement in the synaesthetic community, I have been able to fortify myself from the increasingly diminutive attitude that discourages thinking and perception that does not match to the accepted norm. At this stage in my life, my experience and accreditations have allowed me the reputation of having a certain expertise around the subject of synaesthesia, despite my obvious naivety from my own point of view. When I find myself within arenas ignorant of synaesthesia, I feel safe to be able to breach the subject and begin to fill in the gaps with hopes of spreading awareness and understanding.

How do you feel about the way the synaesthesia you express in your creativity is being received by others? Do you think your synaesthesia isolates or connects you to other people? Could you use your synaesthesia more extensively in art-making? Would you, even at the risk of being misunderstood?

I am not always aware of how others receive my work. I am sensitive that many people don't want an artist coming along and telling them about the details of their work; they want to figure it out for themselves. While saying this, in addition to my endeavour to create art, I have become dedicated to building awareness of synaesthesia and encouraging others to pay closer attention to their own sensory experiences. I engage in conversation about my work whenever it feels appropriate. Conversations about my work most often result in fascinating exchanges, which frequently enlighten me as much as anyone else. I have been fortunate enough to have many of those who have come across my work, either in exhibitions, online, via word of mouth or accidentally, reach out to me to engage further. This includes students of art, media and science who want to learn about and from my work, as well as fellow artists or people who are generally interested in art and new ideas.

It feels to me that many of those who are closed to the idea of synaesthesia, and other less standard concepts that can sit at the root

of art, are not only closed to specific concepts but closed in general to whatever might contradict their worldview. I hope that my work can challenge this a bit, perhaps catching viewers off guard and forcing them to see things differently.

Paying attention to one's synaesthesia might develop its use for artistic means. Tatyana Fuchsmann, of the RSC, asks if one, having already one type of synaesthesia, can develop it to have more sensory qualities (say, colour enriched by taste) or develop another type of synaesthesia. How about your synaesthesia? Did it develop, enhance or change in any way through artistic practice or by other means?

I am certain that perceptive abilities can be developed and honed with practice. As an artist, I pay very close attention to the details of what my senses perceive and how I feel and what I think about these perceptions. In doing this, I experience much more detail of my perceptions and retain a better memory of what it is I have experienced. By way of producing art that is a direct reflection of my sensory experience, their details are imprinted more heavily into me, as if being lived in a layered fashion. It is due to this repeated practice that I have engaged in discovering more and more previously unnoticed aspects of what my senses were picking up and how my brain was responding to these things. I believe that the processes I have become more aware of through my artistic practice have always been part of what was going on with my sensory perception, but it took the practiced observation and reflection to recognise the details of their occurrences. I have always been aware of my synaesthetic experiences of sound and the ideasthesia I experience related to certain kinds of concepts. No entirely new forms of synaesthesia that I have noticed have developed in me through my artistic practice; what I was already experiencing has merely become much richer. Through my involvement in research into synaesthesia, however, I have gained a deeper understanding of the broad spectrum of synaesthstic experiences and can empathise with other ways of sensing the world.

Timothy B. Layden, *Kitchen Purr*, oil on canvas, 100×100 cm, 2010.
Based on synesthetic response to a soundscape composition

Timothy B. Layden,
Tereshkova.
Mixed media on canvas.
49×83 cm, 2016.
"I listened to recordings of space that I found on the internet to use my synaesthesia to influence the background and illustrate a sense of what the atmosphere may be like outside of Earth."

Timothy B. Layden,
4 Sounds.
Mixed media on canvas.
50×70 cm, 2016.
Based on a set of 4 sounds created by Klaus Schmidtke and Christine Söffing as part of an investigation into the shape of sounds

You are an artist whose style of representing objects and colour is very special. Could you explain what meaning you try investing into such an attitude of using colour and form? Specifically, you have a portrait of the Russian cosmonaut Valentina Tereshkova, the very first woman in orbit. Its manner of drawing is very unusual. Why and how did you paint it? How much does it have to do with your synaesthesia?

In my work, there is a constant play of intuitive responses to the immediate balanced by an attempt at objective responses to faithfully represent my sensory experience of the world. The process of creation is one of a relationship of sorts with the work itself. As I engage in the creative process, my actions are constantly being informed and re-informed by how what I am creating changes through my interventions. At the same time, I am working with a plan based on sensory perceptions and ideas that came to me and inspired me before I began the practical tasks involved in the creation of the artwork. The nature of the materialization of the artwork bends the idea and forces a compromise that brings me to fall into what feels like an act of nature interacting with nature to create an imprint of my ideas influenced by the process of bringing them into being, altering them to become a new thing, previously unimagined.

While working, I often use sheets of paper to lay my brushes on and pour extra paint, ink and other excesses over rather than throw anything away. Occasionally, out of the residual stains, something calls to me. I have always been fascinated in space exploration and particularly the history of early space explorers. It was therefore quite an exciting moment to see the edge of Valentina Tereshkova's face and her distinctive hairstyle standing out amongst the abstract shapes of vivid colour on the page of discards that sat on my drawing table. I worked within the stains on the paper to pull Valentina out of the mess, along with the shape of a human heart, which I believe she had quite a strong one, and the shape of a sphere. Other shapes and patterns were emphasised around these to create the balance I spoke of before; I listened to recordings of space that I found on the internet

to use my synaesthesia to influence the background and illustrate a sense of what the atmosphere may be like outside of Earth.

We have explored how you use your synaesthesia to advantage in your artwork. However, have there been times where it has obstructed, or gotten in the way of your producing good art? Situations where you have realized—or learned the hard way—"No, don't do that"? If so, could you give a few examples?

Some of my earliest paintings are highly influenced by my synaesthetic experiences, though at the time of creating them I was much less aware of how the experience of listening to sound while drawing and painting was affecting the outcomes of my work. It was not until about 10 years after beginning my art practice that I began to pay close attention to my synaesthesia as a primary source. I then became much more discerning about the type of sound stimulus I would allow myself while working on an artwork, often choosing specific sounds to be played repeatedly, therefore making them the subject of my work. Not all of my work is entirely based on my synaesthesia. I create a range of work and at times it is important to not allow my synaesthesia to interfere with what I am creating. I do love listening to music but have had to stop doing so in many cases while creating more illustrative artwork not linked to synaesthesia, particularly in cases where I am doing a commission with a specific brief. In the past, I was less concerned about whether I was influenced by the unplanned effects of unexpected stimuli. Now, however, despite the fact that, when given the opportunity, I will freely indulge in experimental explorative work, creating while observing the shifting changes of my synaesthesia, I often try to control the stimulus around me while working to be able to focus more on specifically planned outcomes.

Carolyn ‘CC’ Hart:

> “Foremost, synesthesia is an appealing trait for talking about neurodiversity, for helping people understand how unique our brains can be, and that our neurocognitive worlds can be profoundly different.”

Carolyn ‘CC’ Hart is an author, artist, manual therapist, and polysynaesthete. She holds a Master of Fine Arts in Writing from the University of San Francisco, and is a published poet and essayist. Her mixed media artworks examine the relationship between synaesthetic perception and anatomy, and have been shown in galleries in the United States, Spain, and Russia. She served as the resident costumer for Merced Shakespearefest; her designs have appeared in more than 50 theatrical productions. Carolyn ‘CC’ Hart sits on the executive board of directors for the International Association of Synaesthetes, Artist, and Scientists (IASAS), in the role of Secretary. She has presented at synaesthesia symposia in Ireland, Spain, Russia, and the United States, where she has revealed first person accounts of the synaesthetic experience. Carolyn ‘CC’ Hart lives in San Francisco, California, where she has a manual therapy clinic focused on soft tissue injury and dysfunction. Her paper *Mirror Sensory Synesthesia and the Practice of Manual Therapy* appeared in the 2017 special edition of *Multisensory Research*. Carolyn ‘CC’ Hart is an outspoken advocate for human neurodiversity, and has been featured by the BBC, CNN, and other media outlets. She appears in the 2019 documentary *Human+: The Future of Our Senses.*

Share how you came to know that you have synaesthesia, your earliest memories about it and how much having synaesthesia influenced your understanding of who you are and what the world is like for you. What roles does synaesthesia play in your life? Does it make you more creative? Are there any other "unusual" thought processes or anything that seems inexplicable in the 'workings' of your mind?

I was 46 years old when I learned the word "synesthesia", old enough to have spent half my life wondering why there was such a constant disconnect between my experiences of my sensory world and what seemed to be a very different sensorium inhabited by my friends and family members.

My first memories of synesthesia are from early childhood. I learned to read at three years of age, in part because my older sister was learning to read, and I wanted to be just like her, but also because it seemed so easy. I already knew all of my letters, and the sounds they made. It was so simple to differentiate the alphabet… the beautiful marine blue of the letter A, the striking pink letter E, the snow white O, the crystalline I, the dove grey U. Those vowels, paired with a vibrant palette of consonants, created words that were instantly recognizable to me. Additionally, the book I first read in its entirety with no help from my parents or sibling was phonics based, "A Pig Can Jig". I believe the phonetically constructed syntax paired with my synesthesia created a smooth entry into decoding written language. I still see that book title, *A Pig Can Jig*, in the life-long hues of my lexeme → color synesthesia: aquamarine blue (A), bright yellow (Pig), cerulean blue (Can), concord grape purple (Jig).

I also remember having experiences with mirror-touch synesthesia at a similar age. My parents gave me a German Shepherd puppy for my fourth birthday. Just a few weeks after she came to live in our home, my dog was injured trying to jump over a barrier meant to keep her safe and contained while my mother cleaned house. I witnessed my pup sustain a compound fracture, and when her femur ruptured, I felt shocks of fiery electric pain shoot down the backs of my legs

and across my arms. Fortunately, our veterinarian was able to set the bones and cast her leg. But every time I saw that cast, I again felt pain in my own legs. And of course, I assumed everyone had this same sensation. I became fearful of being in proximity to my pup, even though I loved her dearly. Yet my sisters seem to be fine caring for the puppy and cuddling her. This was my first sense that something was "wrong" with me.

In my teen years, my mother tried to nudge me toward choosing a healthcare occupation. She was the Assistant Director of Nursing at the county hospital, and firmly believed that medical careers were a great choice for me and my two siblings. My older sister Elizabeth was already taking entry level nursing classes, even as a high school student. My mom hoped I would choose to go to college and study physical therapy; I think she noticed my mirror-proprioception and thought my understating of other people's bodies would be an asset in this profession. But, every time my mother tried to get me to join her at the hospital and meet the physical therapists who worked in the clinic, I would balk. I said I wasn't interested, or worse, I would agree to a meeting, then never show up. I spent so much time wondering to myself how can my sister and my mother be around injured people all day? How can they work in hospitals? I knew the answer; I was flawed, defective, damaged.

I studied comparative literature in college because those colored words were ever so captivating. I never had a plan for my degree; I simply chose the academic field that utilized my strongest skills; comprehension, memory, and history. Time had always existed as a colorful 3-dimensional construct around my body, and I could memorize verbatim long passages of Shakespeare, my favorite writer. Comparative literature seemed like a natural choice.

In college, I was in a terrible motor vehicle accident. In the process of healing from that accident, I had many physical therapy treatments. I also had massage therapy, which made me feel so full of life, renewed, and supported. When I recovered from my accident, I went to a therapeutic massage school and learned to practice manual therapy, the

perfect career for me. When I see myself touch other people, I feel that I am the one getting the massage!

I never told either of my parents or my siblings that I saw words in color, time units in bright hues around my body, or pain when I looked at other people's injuries. My few efforts to describe my sensorial world were misunderstood, and, like many synesthetes, I assumed that everyone had experiences that were exactly like my own. My synesthetic perceptions were so deeply rooted into my understanding of the world that they felt completely normal.

In my 30s, I became suspicious that my sensory experiences were unusual. So, I told my story to a friend who was an exceptionally skilled physician. As we walked through the park in our hometown, I detailed my weird sensitivities. "I've been like this my whole life," I told her. Dr. Nownejad was baffled. "I don't know what to say," she told me. I dropped the subject and resigned myself to the idea that my sensory world would always be enigmatic.

My moment of recognition came decades later, when a client at my therapeutic massage practice mentioned during her session that she sees a field of color float before her eyes when anyone touches her. "It's a form of synesthesia," she said, describing the condition succinctly. "Any of your senses can be conflated with any other. For me, my skin and vision are tied together." Her explanation led me to Sean A. Day's Synesthesia List, and to the book *Wednesday is Indigo Blue* by Richard E. Cytowic and David M. Eagleman. I had my answer.

I do think my synesthesia makes me more creative and always has. I hold a Master of Fine Arts in Writing and I am a published poet and essayist. Additionally, I have served as the resident costumer for a Shakespearean theater company and have deep connections to the performing arts, where I have been an actor, director, set dresser, and costumer. I think that my mirror-touch synesthesia, mirror-proprioception, and synesthesia-for-pain really help me hold a deep sense of what it feels like to live in a human body. I am also a visual artist; my work explores the relationship between medical images and my synesthetic perceptions of the body in radiography.

I do have some unusual thought processes connected to my many forms of synesthesia. I am highly anxious, and some of this seems to be rooted in the visual color and patterns sounds make. It can be hard for me to attend to my visual world with so much auditory intrusion. And, due to my my mirror-touch synesthesia, mirror-proprioception, and synaethesia-for-pain, I literally cannot visit sick or injured friends, especially if they are in hospital. For this reason, I feel like a terrible human being. I have felt such tremendous self-loathing because my family or dear friends were in hospital and I never went to visit them. I just can't handle the physical pain of that situation, even with a heart full of concern and compassion.

What does your synaesthesia tell you about? What can synaesthesia teach others? In other words, what can a synaesthete know about his or her mind, world or art that is not obvious or "open" to non-synaesthetes?

I do think that synesthesia has much to teach others. Foremost, synesthesia is an appealing trait for talking about neurodiversity, for helping people understand how unique our brains can be, and that our neurocognitive worlds can be profoundly different. For example, I have a niece who is on the Autism spectrum. She often struggles with social gatherings of all types, and she has a hard time articulating her experiences in these sensory-rich environments. For this reason, she has been shunned in some social situations, especially when she was a teenager. But, when I explain to people that I perceive sounds as shapes and colors, they are often fascinated. And then I take that curiosity that people have regarding my synesthesia and use it as a tool for opening a dialogue about neurodiversity, and sharing about my niece who is autistic and has her own very unique way of living in the world. I guess I see synesthesia as the alluring "gateway" to dialogues about neurodiversity, that if the general public can get interested, or even fascinated by synesthesia, then we have a path to developing compassion and understanding for all forms of neurodiversity.

I also think synesthesia can teach humanity how truly multidimensional the neurocognitive realm can be. I love meeting other

synesthetes, because even though we have the same trait, we still each have profoundly differing perceptions of the world. No place is this clearer to the eye than having grapheme → color synesthetes create their alphabet in the hues that match their perceptions. They are all so very different!

How would you describe a perfect synaesthetic situation, and/or an absolute experience or lifestyle that feels most comfortable or resonant with your synaesthesia? What piece of art, setting or situation do you consider most representative of your type(s) of synaesthesia? In general, how often do you feel that your synaesthesia is discordant and concordant with the world "out there"?

I had one of the most perfectly matched-to-my-world synesthetic experiences at the International Association of Synaesthetes, Artists, and Scientists event *Synaesthesia: What is the Taste of the Color Blue?* This symposium and arts events were held in Los Angeles, California, USA, in the autumn of 2017. The arts exhibit included an installation by a synesthete artist from New York named Ann Patterson. *Pathless Woods* was constructed from a rows of colored ribbons suspended from the ceiling of an art gallery, with lights arranged to create a pattern that wove its way through the grid of ribbon streamers. I am a highly tactile person, and walking through "Pathless Woods" and letting my hands run through the ribbons gave me such a sense of calm and peace. I have touch → color synesthesia, and the hues I was seeing in my mind's eye (I am an associator, and infrequently a projector) were so harmonious with the colors of the actual installation. It was such a moment of pure joy; I will remember it forever.

Sadly, my synaesthesias are often discordant with this world. I would like to note here that I think most grapheme → color synesthetes absolutely HATE seeing the word "synesthesia" spelt out in colored letters because it is ALWAYS the wrong colors. Go to the Wikipedia entry for "synesthesia" for an example. I don't know for whom those colors are correct, but it's not me, and it's probably not the other millions of grapheme → color synesthetes in this world. Even worse,

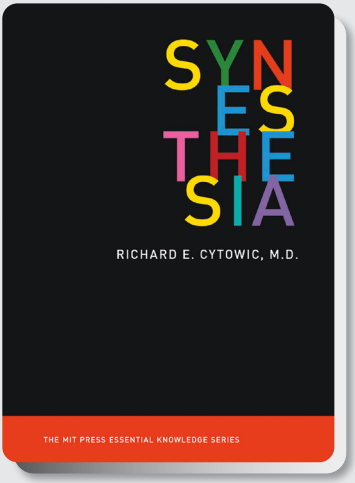
Colours of the English letters as synaesthetically perceived by Carolyn 'CC' Hart. Digital image created by Carolyn 'CC' Hart

"Synaesthesia letters" as presented in a "typical" picture of synaesthetic experience of graphemes.
Video source: Knowing Neurons, YouTube

some illustrators don't bother to note that if one has grapheme → color synesthesia, and your letter S is coral pink, then it is always coral pink, not sometimes blue, and other times purple. See the image below which makes me want to light my hair on fire and put it out with a hammer.

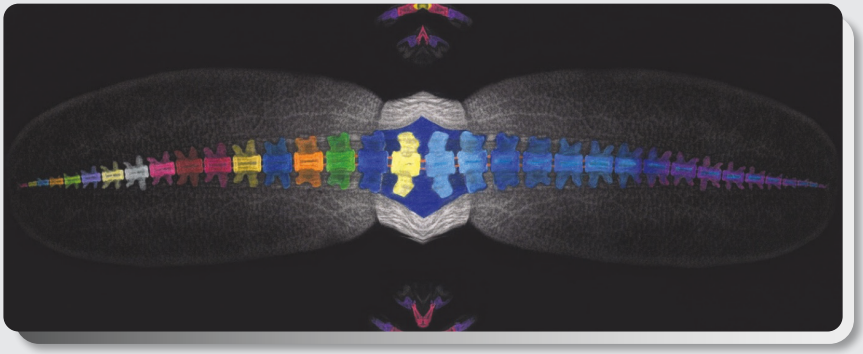
What a mess above!

I do think using a variety of colors to spell the word "synesthesia" CAN work, and might help non-synesthetes understand the synesthetic experience. See the cover to Richard E. Cytowic's book *Synesthesia* (2018), which is beautifully rendered.



Left: The cover of *Synesthesia* by Richard E. Cytowic, published by The MIT Press, 2018. Printed by permission of MIT Press

Below: Carolyn 'CC' Hart, *Castor*, dye sublimation on metal, 40.5×20 cm, 2019. "I consider radiography to be a form of portraiture, both an actual and symbolic representation of the person. And radiography as a medium, in its depiction of one's skeleton, captures the most durable aspect of our temporal bodies."



What was your first encounter with another synaesthete like? Do you understand other varieties of synaesthesia that you do not have? Which would you like to experience (and why)? What type of synaesthesia would you create if you could? What do you think makes synaesthesia a component of art (if you do so)?

The first time I met another mirror-touch synesthete (MTS) in person, Marjan Vayghan, I cried. I had already participated in some

academic projects related to MTS, and I had also appeared in some popular culture writing focused on MTS. But I had never met another person whose sensorium is so much like my own. She gave me a hug that was like nothing I've ever felt. To this day, we are friends.

Also, I was included in an article for the *British Psychological Society*'s magazine titled *The Surprising World of Synaesthesia*. That article included James Wannerton sharing his experiences with lexical → gustatory synesthesia, along wth my recounting of MTS. A year later, I met James at the 2016 UKSA Synaesthesia Symposium at Trinity College, Dublin, Ireland. James greeted me with such profound warmth, I knew I had connected with my neurocognitive tribe.

People with synesthesia are my neurocognitive family. I absolutely love them! Many of my "synnie" friends have forms of synethesia I don't have, for example gustatory synesthesias. I don't have them routinely, although I have had a few fleeting moments of taste → vision synesthesia, and there really is the neurological capacity to have singular and random synesthetic moments. But I think gustatory synesthesias are also laden with challenges; what happens if your sweetheart's name is a flavor you hate? I think every form of synesthesia has blessings and curses.

In regard to what makes synesthesia a component of art, I believe that the capacity for synesthesia is already inside of all of us. Some people have synesthetic experiences when they are sleep deprived, but not otherwise. Or when they are under the influence of certain substances. Or when they are having a peak experience. I think the hyperconnectivity of synaesthesia calls to all of us. So when we read Emily Dickinson's poem *I Heard a Fly Buzz When I Died*, the bug's "blue buzz" is something we can relate to, it's in us all, even if we are not synesthetes, even if a typical housefly's buzz is ochre yellow as it is for me.

Do you remember any significant life events that may have played roles in developing or reinforcing your synaesthesia? What external factors and conditions are conducive to or hinder your synaesthesia? Have you ever done anything "against" your synaesthesia; for example, suppress

it or experience something contrary to your synaesthetic reaction? If yes, what? If no, why?

It's worth noting here that I cannot suppress my synesthesia. And, when people suggest I just "turn it off", I know that they do not have any understanding of what it is like to be a synesthete. It is beyond my ability to control, and all suggestions that I can just get over it, or ignore my synesthesia make me furious.

If I want to encourage my synesthesia to become more flagrant, I can do the following: deprive myself of sleep, drink too much coffee, smoke some cannabis, meditate myself into an alpha state, eat enough chocolate before bedtime so that I am plagued with hypnogogia and extreme chromesthesia.

If I want my mirror-touch synesthesia to take a back seat, I can try getting good sleep, no caffeine, and meditating on the idea of being psychologically strong. The first two concepts help a little. The last, not so much. It's rather pointless to think to myself "I wont's have mirror-sensory pain". It's in me. It is me.

In regard to MTS, which is for me my most dominant synesthesia in that it causes me much distress, I think it was encouraged by that youthful experience noted above where my puppy broke her leg and I witnessed that injury. I was also hospitalized for a surgery at age 6, and I can remember having much mirror-sensory pain looking at the other children in the ward, including the very kind boy next to me who had his casted leg in traction. To this day, casts and crutches send bolts of stinging pain down my own legs.

How do you feel about the way your synaesthesia, when you share about it, is being received by others? Do you think your synaesthesia isolates or connects you to other people? Could you enhance or use your synaesthesia more extensively in adapting to or transforming the world? Would you, even at the risk of being misunderstood?

It makes me so sad when people think that synesthetes are just trying to get attention, or that we are "snowflakes", people who are overly concerned with our own sensorium.

But often people are fascinated by synesthesia, and this is place where I feel synesthesia can do so much good in the world. For example, my younger sister has dyslexia. If people can get really interested in the ways in which synesthesia denotes cognitive differences, can we not also develop more compassion and interest for people struggling with dyslexia? Can we make the world a little safer for them to talk about their cognitive differences?

Has your synaesthesia ever been scientifically studied? (If yes, share how!) How do you feel about being studied? What would you like to know about synaesthesia that is not yet discovered? What recent discovery about synaesthesia was most revealing to you?

I took the *Synesthesia Battery* several years ago and scored a high correlation to grapheme → color and time-units → color. My MTS has never been studied in a laboratory. One of the challenges here re MTS is that one cannot simply ask to be a research subject and get the fMRI tests that might be conclusive.

But I've participated in many research studies focused on various forms of synesthesia, and I always feel like I am doing my part to help further the understanding of cross-sensory experiences. And, I like being studied… the people researching synesthesia are so bright and curious and engaged. It's really a pleasure to have conversations about neurocognitive differences.

Also, sometimes it shows me something about my brain I hadn't noticed before. For example, I participated in a study a few years ago where the university accessed my Synesthesia Battery results, then put me through a series of memorization tests using letters. I recognized early in the test that sometimes it was so easy to recognize a string of 4 letters, but other times it was really difficult. At the end of the test, the researcher asked me, "Do you have an idea about what we we're testing?" I told her Yes!!! I got it!! When they gave me strings of letters that are similar colors, for example IOUX, those were harder to remember, because they are all shades of white/grey. But when they gave me 4 letters of different colors, for example BKYS, those were so easy to recount even 15 minutes

after I had been asked to memorize them because the colors are so different: scarlet, seafoam green, chartreuse, primary blue.

I'd really love to have a clearer picture of the genetic mechanisms that are at play with synesthesia. I hope researcher such as Amanda Tilot will help humanity learn more about this.

I am also curious about the co-morbidities that pair with synesthesia. I have ADHD, sensory processing challenges, narcolepsy, and I had Tourette as an early teen. I am also on the spectrum, and I think this is all related to synesthesia… not causal, but more like partner traits.

How are your types of synaesthesia related to your art-making? Why did you choose those specific media (radiography images, for example)? Can you please describe the creative process and intended message of your visual art? What other creative art projects and experimental prototyping have you been involved in or contributed to (besides media coverage)?

I have many different forms of synesthesia, and I consider myself a polysynesthete (general sounds → vision, grapheme → color, lexeme → color, number forms, time units → color, spatial → sequential, mirror-touch, mirror-proprioception, synesthesia-for-pain, orgasm → color, touch → color, musical notes → vision, sound → touch, flavors → vision). I'm also a multidisciplinary artist, with a background in theater performance and production. My Master of Fine Arts degree is in writing; however, the creative discipline that is a current source of curiosity and focus is multimedia visual art.

Synesthetic perception dominates my sense of the world, and has a huge impact on my creative interests. For example, when I was active in the performing arts, my mirror-touch synesthesia helped me embody the roles I was portraying, pushing me to find a deeply physical sense of character. In regard to costume design, I feel that my touch → color and sound → color synesthesias help me create garments that reveal a language of attire through emphasis on the

subtle sounds textiles made when actors move, and through a reliance on fabric textures to convey feelings such as desire, revulsion, and hope.

I am currently working on an installation titled *Bone Stories*, born from my work in manual therapy, my keen interest in pathophysiology, and the ways in which mirror-touch, mirror-proprioception, synesthesia-for-pain, touch → color, and grapheme → color influence my conceptualization of other people's bodies. Because one can't simply turn synesthesia off, my clinical practice is constantly under the influence of my cross-modal perception, and this becomes an inspiration for creating visual art.

I was talking to Richard E. Cytowic at the IASAS 2017 symposium, and sharing with him the fact that I see radiographic images in associated synesthetic colors that correspond to my colored graphemes and lexemes, but that are also influenced by my mirror-sensory synesthesias. Richard encouraged me to continue exploring these phenomena, especially because of this intersection between art and science. I started scanning analogue and digital radiographs that depicted orthopedic pathologies, and then having them printed to canvas. I then overlay them with color using oil pastels and pencils so that the completed canvas reveals an alternative way to view the body and pathology.

Additionally, I consider radiography to be a form of portraiture, both an actual and symbolic representation of the person. And radiography as a medium, in its depiction of one's skeleton, captures the most durable aspect of our temporal bodies. *Bone Stories* is a dialogue between the intangible abstractions of our minds and the most tenacious physical structures of the human body.

But *Bone Stories* is also an exploration of the intersection between the patient's perspective toward her injury and my own interpretation of that injury, which of course will always be influenced by my synesthesias. (My inspiration comes from Charon, R. (2001). Narrative Medicine: A Model for Empathy, Reflection, Profession, and Trust. *JAMA*, *286*(15), 1897–1902. doi: 10.1001/jama.286.15.1897).

According to Charon's research, "The effective practice of [healthcare] requires narrative competence, that is, the ability to acknowledge, absorb, interpret, and act on the stories and plights of others".

Have any aspects of your synaesthetic experience changed, developed, appeared or disappeared in the long run? Have you ever experimented with your synesthesia with any unexpected, stunning resulting effects?

When I was a child, I had color → tactile synesthesia. This is now gone. But I remember it quite clearly at least for a few colors. My recollections are below:

In Merced, the little city where I was born, not a single retailer carried Le Creuset. My mother had become enamored with the heavy cast iron and enamel cookware after watching numerous episodes of "The French Chef" on PBS. So, on a weekend trip to San Francisco, while my mother, my sisters and I were shopping for shoes on Union Square, my father slipped down into "The Cellar", Macy's famous housewares department. He bought a squat Le Creuset Dutch oven in a color the company called "Flame". My dad managed to sneak the package into the trunk of the family station wagon without anyone noticing. On Sunday night, when we had returned to the Central Valley, my father surprised my mother with the large, orange pot.

I hated it.

The smoldering color of that pot made the back of my throat blaze with a scratchy, abrasive pain. My mother would prepare the most delectable Coq au Vin, its succulent aroma wafting through our home. I could appreciate the fragrance of the simmering dinner from the family room of our California ranch-style home, or, if I was in the kitchen, with my back turned to the stove. But the minute my eye caught the color of the Dutch oven, I felt as if I had instantly developed strep.

I was about eight when "Flame" Le Creuset began replacing the aging Pyrex bakeware my parents had received as wedding presents.

The Dutch oven was followed by an au gratin, a terrine and a kettle, all bright as embers. Along with my sisters, I learned to cook with those pots, the three of us making scalloped potatoes a la Julia, layering thin slices of russets into the casserole, its milky enamel lining a cool reprieve from the searing orange exterior.

White gave me an entirely different sensation, as if I was holding a fine, light powder in my mouth, weightless and gelid, enveloping my tongue, my gums, my teeth. This was true when I looked at any white item, just as all burnt orange objects scratched my throat.

But this doesn't happen anymore. I seem to have lost the synesthetic experience of color to tactile perception. The only additional hue for which I can recollect a linked physical sensation is pink. I would get a tingle in my pharynx, somewhat similar to the tickle that precedes a sneeze. But, like other colors, pink no longer triggers any sensory impressions, even though I can clearly remember what it once felt like to perceive colors in my mouth.

I have indeed experimented with my synesthesias. In California, where I make my home cannabis is legal, and one can simply walk into a store and purchase it in a stunning array of products. In general, cannabis is a bad fit for me. I don't like it much and it increases my interoception to a point of profound discomfort. I become acutely aware of every sensation in my body, both painful and pleasurable, which creates a cacophony of visual colors and patterns. It can be interesting for me to experience this flagrant synesthesia, but it's also rather terrifying at times.

I also notice my synesthesia increasing in states of sleep deprivation. I had the most meta-synesthetic moment a few years ago at the IASAS 2017 symposium in Los Angeles. I was exhausted from helping to coordinate the conference, but was excited to watch Michael Banissy's lecture about mirror-touch synesthesia. He was showing images from his lab that are used to test for MTS. The image of a hypodermic needle piercing the skin made me so physically startled that Michael Banissy could see my movements from 15 rows back in the auditorium. He said "CC, you should probably close your eyes". And I did.

Over the course of your life, as you state here, you have encountered quite a lot of fallacies, myths and erroneous approaches to synaesthesia. Could you comment further upon the current trends regarding such misconceptions seen on the internet, such as on social media?

I got into an argument recently with a Reddit user who replied to an original poster who had question about synesthesia. The user with whom I had a back-and-forth disagreement was postulating that schizophrenia and synesthesia are essentially the same thing, and, even when faced with my reply, with appropriate citations of academic papers, he wouldn't back down. It frustrates me to see synesthesia get categorized as a disease on social media, or to see synesthesia associated with conditions such as schizophrenia when there is no (current) demonstrable link. Synaesthesia is a trait, and the perpetuation of the myth that it is a pathology disappoints me. This is why I do not belong to the Facebook group "I have Synesthesia: I'm not a freak, I'm a Synesthete". For years, the group administrators had this community listed as "disease" although it has been updated to a "general" group. But implying that synesthetes are freaks, or are perceived as freakish, is against my interests in promoting neurodiversity as normal human cognitive variations.

I am also frustrated by the assumption that synesthesia is always about colored perceptions, and is constantly alluring or beautiful. This is frequently illustrated by Pinterest memes with psychedelic graphic designs with captions such as "Can You hear the Colors?" or "I See Colors When you Say My Name". It is all so twee and sentimental, when synesthesia can be full of conflict. I wasn't with my father when he was dying because I couldn't handle the mirror-sensory feedback of the hospital environment. This is the truth of synesthesia… it's not always a beautiful experience.

I think synesthesia faces the same challenge as any other subject in regard to social media. These forums can rapidly disseminate misinformation, and are particularly adept at such when the topic captivates the public imagination.

Carol Steen:

> I had no idea, back in November 1995, that synesthesia would become so well known worldwide, gain acceptance, approval, and even envy.

Carol Steen is an artist, writer, curator and synaesthete. She received her MFA from Cranbrook Academy of Art. Her work can be found in many public collections, including The Library of Congress, the Detroit Institute of Arts, and the McLaughlin Gallery in Canada. She has had over 20 solo exhibitions and been in over 70 museum and gallery group shows. Steen has received fellowships from the MacDowell Colony, and the prestigious New York Foundation for the Arts, among others. She has participated in numerous television and radio documentaries worldwide, including *60 Minutes*, BBC, and NPR, and her work is included in over 40 books and articles including the *Wall Street Journal*, *Newsweek*, and the *New York Times*. She is frequently invited to speak about her work at universities and museums around the world and has presented at the University of Cambridge, UK, Centro Nacional de las Artes in Mexico City, the Burchfield Penney Art Center in Buffalo, NY, and at the Royal Institution in London for the University of Sussex. She is the Co-Founder of the American Synesthesia Association, Inc., founded in 1995. Her chapter, *Synesthesia and the Artistic Process*, co-authored with Greta Berman, about how artists with synesthesia create, was published in the *Oxford Handbook of Synesthesia* (2013). Six years ago, she started to see hypnagogic visions and wrote a paper comparing them with synaesthetic photisms. Her current artworks, created using dye sublimation, depict her hypnagogic visions as accurately as possible. Carol Steen is a Professor of Digital Design at Touro College and University System in New York City.

Could you please share how you came to know that you have synaesthesia, and your earliest memories about it? How much has having synaesthesia influenced your understanding of who you are and your creativity? Does synaesthesia play other roles in your life besides art-making and creativity? Are there any other "unusual" thought processes or anything that seems inexplicable in the 'workings' of your mind?

Sometimes, what appears to be bad fortune can turn out to be good fortune in disguise. I was seven years old when I told my best friend, on our walk home from elementary school one Fall day, that the letter 'A' was the prettiest pink I had ever seen. I thought she would agree. Instead, she stopped walking, turned to face me and said, "You're weird." I was very hurt by her response but I had no reply, no defense, no explanation. We continued our walk home but now in silence. We never talked again.

What I didn't know then was that what I had described was one of the more common forms of synesthesia, or that I would remember this conversation for the rest of my life. This mention also marked exactly how old I was when I became aware that I saw the world differently.

But being aware of being different was not permission to talk about it and I didn't speak about my colored letters or any other synesthetic perceptions again until I was twenty. I knew that silence was safer but that didn't mean I stopped observing my perceptions. As a child, I had so many questions but there was no one to ask. There was no such thing as the internet then. I was alone. But that was a long time ago and so much has happened since. Wonderful things.

I grew up in a family of artists and was always surrounded by creative activity happening in one medium or another. I knew early on that making art was all I ever wanted to do. Perhaps because my father was a sculptor, was my first teacher, my family eventually accepted that this would be my path. What I didn't know then was that my father was a synesthete too, and as alone as I was.

Maybe he liked sculpture for the same reasons I did. Sculpture does not require the use of much color. The working materials' colors are

limited to the various greys or rust browns of clay; the rich range of woods' browns; the transparent to opaque whites of plasters and cements; the various browns, blacks, blues, and greens of bronze patinas, the bright shines of gold, silver, and copper; and the duller greys of aluminum, lead, and steel. It was a good medium for me, a good place for me to ignore my synesthetic colors.

I did not turn to painting, and color, until many, many years later. As it turned out, to be able to work with color, I first needed to learn about synesthesia. Then I had to find the courage to break many of the rules that my extensive, formal, and traditional background had taught me. My transition to color happened by accident and came about at the same time I was learning about synesthesia.

I use my colored pain diagnostically. The colors of my ill health, or pain, are always accurate and, if present, tell me if I am sick, just what part of my body needs treatment, and how badly I need it. Seeing black anywhere is really bad; it means I need immediate treatment. Seeing orange means I am going to have a lot of pain soon. I might not feel the pain immediately; rather, I might just see the orange color instead. When I destroyed my left knee in a sporting accident, all I saw, with my eyes open, was orange. Everything I saw was one shade of orange or another. But I did not feel pain until later, after my normal color vision had returned.

My synesthetically seen colors have never been wrong. I have had two root canal surgeries on teeth that were glowing orange. In both cases, the nerves of those teeth were dying. The color disappeared as soon as the nerves were removed and the infections cured.

The difficulty with this particular synesthetic ability is explaining to a medical person that one's seen colors are a warning of an impending health problem. Often, I will see a synesthetic color before I feel pain from an injury, or pain from an illness. Without a physical manifestation of a problem, doctors believe nothing is wrong. My doctors tended to ignore my synesthetic perceptions at first. When the physical symptoms appeared not long afterwards, and I returned for treatment, they were both surprised at my accuracy and they became

more accepting. I continue to tell my doctors about my synesthetic perceptions; it helps them help me. And I bring them lots of articles.

What does your synaesthesia tell you about? What can synaesthesia teach others? In other words, what can a synaesthete know about his or her mind, world or art that is not obvious or "open" to non-synaesthetes?

About 6 years ago, I started to experience hypnagogic visions. Hypnagogia is a normal state of consciousness where visions are seen between being awake and falling asleep. In 2017, I published a paper comparing synesthetic photisms and hypnagogic visions entitled "Synesthetic Photisms and Hypnagogic Visions: a Comparison" (*Multisensory Research, 30*(3–5)). I wondered if others saw them too and began to ask fellow synesthetes if they experienced hypnagogic visions, and if so, what did they see? Quite a few synesthetes told me they see these visions and I wondered, was there a connection between synesthesia and hypnagogia? And, as one kind of vision had a trigger—synesthesia—but the other, hypnagogia, didn't, what could that connection be?

In some things, synesthesia helps my memory. I can remember phone numbers, license plates, and other number/letter combinations easily because of their colors. Synesthesia helps my spelling but perhaps not my punctuation. Commas are black and I like to sprinkle them liberally in my writings; the black commas make the colored letters look brighter.

My synesthesia is useful in other ways too. I cook by the colors of the smells. I hear certain sounds in color but don't know what notes they are, like the start-up chime of the Macintosh computer. If I could remember the name of the colored note, I might learn to have absolute pitch, but I have not been paying close enough attention.

Some people I see have auras. But not everyone. This form is fairly new to me and is developing. For example, if I see a *Pepto Bismol* (a medicine for upset stomachs) pink colored aura around anyone, I know they are a substance abuser and I try to avoid them.

My student roster is organized, in my mind, by the colors of the student's first name. If my students tell me they missed class because they had a family emergency but I don't feel an orange chill run up my

spine, I don't believe them. But I don't tell them that. My husband is a sculptor and often comes home with a small cut on one or more fingers. When I notice that he's hurt himself, I instantly feel the same orange chill run up my spine. Additionally, when I see someone who looks sick, I will get this same feeling. Some researchers call this mirror touch, but I think it's empathy.

None of us sees the world the same way. It would be great if everyone knew that. We are unique in our synesthetic perceptions. They are idiosyncratic. We know others with the same kind of synesthetic ability can see things that are similar to what we see, but not exact. Consequently, we synesthetes are always making comparisons, trying to understand our differences, our similarities. Non-synesthetes assume there are commonalities amongst synesthetes, that we all see things the same way.

Our 'multimedia' perceptions, though unique to each synesthete, can help us understand the many facets that having synesthesia adds to any experience. This enriches our perceptions and knowledge in ways non-synesthetes can't grasp. It's a little like going shopping; one sees the clothes hanging on racks, but gains more information by touching the fabric, as well as looking at the garment's color, style, shape, texture, etc.

Recently, a good friend who is a not a synesthete told me excitedly that she had had an experience where she saw moving colors. Because of her vision, and because she had read my published papers on synesthesia, I asked her if my descriptions of colored, moving shapes were accurate. She said enthusiastically, "Yes!" Though her experience was fleeting and happened just once for a one brief period of time, she saw what we can see, and became one of us! And now she better understands the complex, multifaceted richness of our joined perceptions.

How would you describe a perfect piece of synaesthetic art, or an absolute experience or lifestyle that feels most comfortable or resonant with your synaesthesia?

I do not know how to describe "a perfect piece of art", synesthetic or not, or "an absolute experience or lifestyle that is most resonant"

with my synesthesia. Art is ineffable. Philosophically, I respond to what Abinavagupta (c. 950–1016 AD, a philosopher, mystic, and aesthetician from Kashmir) wrote in the 10th or 11th century. Comparing art to the finest classical Indian cuisine, which is very complex, he said the best meal needed to have many different rasas, or flavors. These flavors needed to be balanced. For example, spicy foods would pair with others that were bland, a variety of textures was important, and other sensations needed to be considered such as the various temperatures of the food, etc.

He said great art needed to be like classical Indian cuisine. It had to have many qualities in the same piece and he described nine 'rasas' that great art should address: the angry, the heroic, the pathetic, the erotic, the cosmic, the terrible, the odious, the serene, the marvelous. Of these nine, he said the most important was the marvelous. Synesthesia often shows me marvelous things.

What was your first encounter with another synaesthete like? Do you understand other varieties of synaesthesia that you do not have? Which would you like to experience (and why)? What type of synaesthesia would you create if you could? What do you think makes synaesthesia a component of art?

My father was a reluctant synesthete. I'll always remember the day I came home from college on a semester break. As was usual when my family was together, we ate dinner in the dining room. My father was an artist and we were used to talking about all sorts of topics. That day, there was a companionable silence as we ate our dinner. I took advantage of the silence, I don't know why I said it, but I announced, "The number five is yellow." My father looked at me and immediately said, "No, it's yellow ochre." My mother and brother looked at each other wondering if this was a new game they were unfamiliar with. My father didn't catch their facial expression of bewilderment, so I quickly asked him what were the colors for the numbers 2 and 6. To me, both were the exact same value but one was green, the other blue, I just wasn't sure which number was which color. My father said, "Two is green." Then, he noticed the interest on my mother

and brother's faces and fell silent. At that time, I had no information about synesthesia, didn't even know this ability had a name. I tried to ask him additional questions but he changed the topic. For the next thirty years, he refused to talk about his colored numbers and letters. Finally, when there was some published information about synesthesia, he began to speak about his colors, but he always spoke about them with restraint, as if he wasn't quite sure it was okay to discuss synesthesia.

I understand some of the other varieties of synesthesia that I do not have, either because they seem similar to forms I do have, or because I have experienced them, but only once. For example, I do not have flavors from sounds, but one day, when listening to a song I liked a lot, I noticed that, when the 'hook' in the song played, I tasted tobacco. Specifically, I tasted it just on the outer edges of my tongue. I must have played that song 10 times in a row, or more, to check and recheck my experience. Each time I heard the 'hook', I tasted tobacco. But when I played the song the next day, nothing happened; I tasted nothing. I do not know why this happened but now I better understand the experience of those for whom any trigger produces a taste.

I do not have time → space synesthesia and wish I did. I have a terrible sense of direction, get confused with left and right, and, back in the era of cassette tapes, where songs were recorded on both sides of the tape, I could never find which was the proper side, the one that held the song I wanted to listen to. Often, I would have to start the tape at the beginning and listen to it all until it came to what I wanted to hear. I have always wondered if having time → space synesthesia could be helpful to me, though I know a synesthete who has time → space synesthesia and her sense of direction is as bad as mine.

If there were a way to hear a spoken language that one does not already know and have it translated immediately, that would be a superb synesthetic skill to have.

I wrote a chapter, with Greta Berman, for the *Oxford Handbook of Synesthesia* (2013). In our chapter, entitled *Synesthesia and the Artistic*

Process, we go into great detail about evidence of synesthesia that can be found in the works of artists who may or may not have known they were synesthetes. We explore what to look for in artworks.

What piece of your art do you consider most influenced by or representative of your synaesthesia? Do you remember how you created it? What other artists not known to have synaesthesia do you feel were nevertheless synaesthetes? Why?

Not that long ago, discussions about synesthesia were few and far between. It wasn't until the media discovered synesthesia, and many books, articles, and scientific papers were written, that I felt comfortable enough to tell people about my abilities.

Usually, I was asked, "What does what you see look like?" I often tried to describe what I saw, as well as what triggered my perceptions but quickly discovered that words couldn't explain what I was seeing very well. In frustration, I did a painting entitled *Vision*. This was the first time I painted just my synesthetic photisms. Now I had something I could show people. I could point to my painting when I needed to describe how my shapes formed, where they came from, where they went, how they moved, and for how long I could see them. But what I still can't explain is why I can see what I see.

During an acupuncture session one day, I saw this particular vision. It began as a pinpoint sized laser dot that exploded into a red blobby shape. On top of this red shape, numerous green comma-like forms appeared. They entered my visual field and moved together like a herd of agreeable animals. I could watch them appear from the upper left and exit toward the top right of this 'movie screen' in my head. Other forms came into sight and moved around as well, on top of or behind other moving forms. The black background on which I watched all these moving colored, soft edged forms was moving too, gently. When the acupuncturist removed the needles, one by one, the image became frozen and everything I had watched disappeared as all the needles were removed. I went home immediately and painted what I remembered having seen. This painting is a synopsis of that experience. The essence of what I saw is correct.

I have a long list of artists whom I believe might have been synesthetes. As I am still doing research, I prefer to share these insights in my next paper.

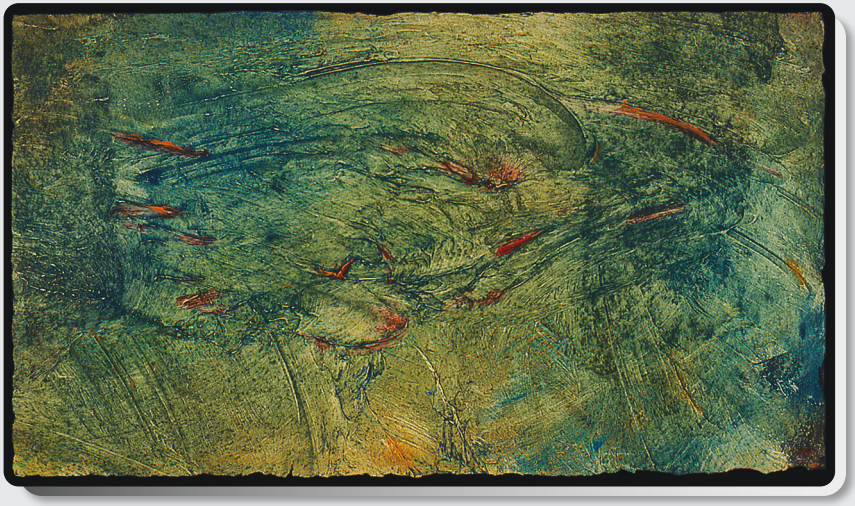
Do you remember any significant life events that may have played roles in developing or reinforcing your synaesthesia? What external factors and conditions are conducive to or hinder your synaesthesia? Have you ever done anything "against" your synaesthesia; for example, suppress it or experience something contrary to your synaesthetic reaction? If yes, what? If no, why?

It was August 31st, 1993, at 1 pm, the day I finally got information about synesthesia! The day started off as usual. I was working at a summer job sculpting various, small, licensed figures for a company that reproduced well known cartoon characters like Bugs Bunny, or Mickey Mouse. These were made for fast food companies like McDonalds. The sculpted characters we created were reproduced in the millions, collected by millions of people, and available when one purchased a special type of meal at a McDonalds, or a Burger King fast food restaurant.

That day, the four of us, all sculptors, sat in a small cubicle working. We would pass the sculpts around, handing them off to a colleague whenever we'd get bored. The pieces rotated amongst us and we would talk as we worked. I had mentioned my synesthesia and asked my colleagues if anyone had it. Of course, no one did. I didn't pursue the topic. But, on this particular day, I hadn't taken my cassette player into work with me; the batteries had died. I liked to listen to music but the woman sitting next to me never did; she enjoyed talk radio more. On this particular day, she suddenly turned to the woman behind me, gently lifted the headphones off her head, and put them on my head saying, "Carol has to hear this."

I immediately heard the radio interviewer introducing Dr. Richard Cytowic, who had a new book coming out about synesthesia. This was the first time I had ever heard the word spoken that wasn't part of a conversation I had initiated. This was being discussed in public, on the radio! Dr. Cytowic knew more about synesthesia than I had

Carol Steen, *Vision*, oil on paper, 15×12 3/4 inches, 1996.
"During an acupuncture session one day, I saw this particular vision. It began as a pinpoint sized laser dot that exploded into a red blobby shape. On top of this red shape, numerous green comma-like forms appeared."



Carol Steen, *Water Blue,* 8 1/2×5 inches, oil on paper, 2003.

"Story of *Water Blue.*

I have always experienced wonderful visions during acupuncture. Once all the needles are in place, at the right depth, I can tell by the colors I see which needles are on the same meridian. I watch the colorful moving photisms with my eyes shut. The visions last until my acupuncturist removes the needles.

I've learned, if I don't paint what I remember from an acupuncture session as soon as possible, the memory of what I had seen will fade. And fade fairly quickly too. Consequently, my paintings from acupuncture touch tend to be small. I can only paint a fraction of what I have seen, but the colors, shapes, and movements are truthful to the experience.

This is what I saw one day in 2003 during an acupuncture treatment. *Water Blue* is so named because I kept some transparency in the paint. I let the paper's white background become visible. Water can be transparent, and many colors of blue. I kept the layers I saw. I kept the changes in the background. This painting was done in one day. I do not use brushes; I use my gloved hands and work very fast.

Doing these paintings taught me to trust my visions, to trust my skills as an artist though I was exploring a completely uncharted world, one unknown to the taste makers of the 'art world'. I painted an internal landscape that was not abstract, rather it is very real. These paintings also taught me to be patient, and to believe that the 'art world' would one day catch up to what I was doing and understand why I was doing it. This has proven to be true. Synesthesia is big in the 'art world' now."

been able to discover in my entire lifetime of searching. I was absolutely stunned. I got in touch with him a few weeks later. Here, in New York City, it is okay to interrupt anyone; we do that to each other all the time, and I had a lifetime of unanswered questions. I can tell you that he did not get one complete sentence out in the twenty-minute conversation we had. He generously gave me knowledge that day and it changed my life.

Hinder: Fear can turn off my synesthesia. If a car comes out of nowhere, barreling down a New York City street that I'm in the middle of crossing, my synesthesia disappears as I run for the safety of the nearest sidewalk. When I am calmer, it returns. It disappeared when my mother died but came back when I wasn't grieving so much. It diminished a lot once when I had to take a particular medicine to cure a parasite I had picked up in India. My synesthesia returned when the medicine had done its work and was out of my system. Karaoke singers are often terrible and I always want to get away from those sounds. I think that is called misphonia. Music that should be heard in stereo, but one speaker doesn't work, is like being blind in one ear.

Amplify: Wonderful music played on a synthesizer, gives me the best colors. Loud music is more colorful than softer volume music. Acupuncture shows me marvelous, moving, colored, shapes. I create using what I see from sounds, music, and acupuncture.

I don't know how to suppress or go against my synesthesia. All I can do is try to ignore it if what I see is unpleasant. Sometimes, that is possible; other times not. I like my synesthetic experiences 90% of the time. They are useful, and truthful.

How do you feel about the way the synaesthesia you express in your creativity is being received by others? Do you think your synaesthesia isolates or connects you to other people? Could you use your synaesthesia more extensively in art-making? Would you, even at the risk of being misunderstood?

People know my work comes from my synesthetic photisms, and now from my hypnagogic visions as well. I have been told by both

synesthetes and non-synesthetes alike that they really like my work. They tell me that there is something familiar about my work, but can't tell me just what that is.

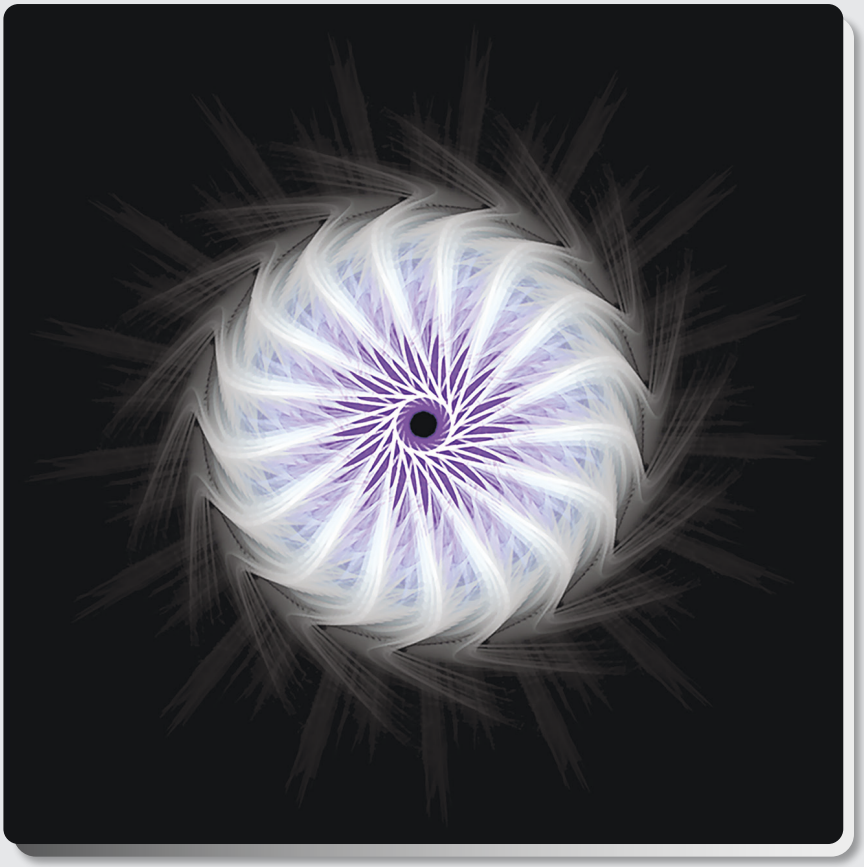
I believe it connects me.

I use my synesthesia, and my hypnagogia, in my work all the time. Both are a great inspiration. What I see intrigues me. Though it is often impossible to capture much of what I see and put into a single still image, I sometimes make numerous images of the same experience, if it is a good one. Using my synesthesia has caused me to break many traditional art making 'rules', because they don't work. For example, I do not use brushes to paint because what I see happens so quickly that, by the time I mixed a color and loaded it onto a paintbrush, the experience would be long over. Sometimes, working with my visions requires me to learn a new medium in order to work with what I have seen. I learned Photoshop so I can create my hypnagogic images.

Artists and artworks have often been misunderstood. This is nothing new. We artists are often working at the forefront of new perceptions, information, and/or technology. This means that what we produce is new and new means many people need time to understand what we have created in response to whatever new information inspired us to create.

Together with Pat Duffy you established the American Synesthesia Association (ASA). Sean A. Day and others were very important to the ASA. What were your initial thoughts and aspirations behind this? What were the teething problems you encountered? Did the mission turn out as envisioned in the very beginning? What missions are such societies pursuing today, when awareness of synesthesia seems to have reached a state of "marvelous indifference" (to reiterate Richard Cytowic's statement)?

One November evening in 1995, Pat Duffy came over to my artist loft here in New York City. We had been introduced by Simon Baron-Cohen, a Cambridge Don. He thought that two synesthetes who lived in the same city should know each other. When we met that night,



Carol Steen, *Hypnagogic Vision*, digital image, 2017.
"About 6 years ago, I started to experience hypnagogic visions. Hypnagogia is a normal state of consciousness where visions are seen between being awake and falling asleep."

we told each other about our journey—how we discovered the word for our abilities, synesthesia, and more. Both of us had experienced great difficulties. Each of us had tried for years and years to get any information. We agreed that, for both of us, knowledge came slowly, sparingly, unexpectedly, always in tiny bits and pieces. We might learn a word here, a definition there—that later often turned out to be incomplete, or incorrect. As we shared the details of our respective searches, we realized we could not be the only synesthetes in the world. How could we find others? We decided to try to make it easier for others to find each other, and to get useful information. That night, the American Synesthesia Association was born with a membership of two.

There was already one synesthesia organization that existed, the International Synaesthesia Association (ISA), headed by Simon Baron-Cohen at Cambridge, UK. I was involved with it. But the ISA was located in England. The internet was very new, terribly slow, and few people had access to a computer, let alone owned one. Computers were extremely expensive. We wanted to have an organization here in the States.

I invited Sean Day, and Peter Grossenbacher, to join me to work toward becoming the first, and so far, the only not-for-profit synesthesia organization in the world with a government sanction. We three formed the first Board of the ASA. I found a pro bono lawyer, Chinyere Okoronkwo, who worked with us for many years as we incorporated and dealt with the Internal Revenue Service (IRS), the very exacting, financial, and tax collecting part of the United States government.

In order to become a not-for-profit organization, not an easy or fast thing to accomplish, the IRS asked us very specific questions, requested we supply numerous documents, and sent us lots of legal forms to fill out and return, precisely. What was amazing to us, in the early years of forming our not-for-profit organization, was that every time the IRS requested specific information, an article on the very topic they wanted to know about would appear in a highly regarded national publication, like *Newsweek*, *Smithsonian Magazine*, the *Wall Street Journal*, or the *New York Times*. Every single time. We would add

these articles to whatever the current request was and mail everything off to them, then await the next set of questions or requirements. At times, what the IRS wanted seemed endless. Finally, in 2004, after 8 years of hard work, the American Synesthesia Association, Incorporated, became a 501(c)(3) not-for-profit organization with permanent, public charity status.

Our mission statement reads:

> "The purposes for which the Corporation is organized and operated are: to foster and promote the education and advancement of knowledge of Synesthesia; identify individuals who experience synesthesia; promote and provide a means for such individuals and those interested in the research, history, theory and useful applications of synesthesia to be in contact with each other; to foster awareness and appreciation of synesthesia and the abilities of synesthetes in this country."

The American Synesthesia Association is now in our 24th year and our current Board Members are Lawrence E. Marks, Edward M. Hubbard, Greta Berman, Daphne Maurer, and Carol Steen.

In addition to our Board Members, we are grateful to all those who have hosted our conferences over these many years. They include Lawrence E. Marks at Yale, Charles Gross at Princeton, Vilayanur S. Ramachandran at the University of California San Diego, Lynn Robertson at the University of California Berkeley, David M. Eagleman, currently at Stanford University, Eric Odgaard at the University of South Florida, Randolph Blake at Vanderbilt University, Daphne Maurer at McMaster University, Berit Brogaard at the University of Miami, Robin Kingsburgh at OCAD (Ontario College of Art and Design), and Takao Hensch at Harvard University.

Additionally, we are grateful to all the many synesthetes, scientists, artists, researchers, curators, and creatives for their contributions to the body of knowledge that is available to those who live with, use, and study synesthesia today.

I had no idea, back in November 1995, that synesthesia would become so well known worldwide, gain acceptance, approval, and

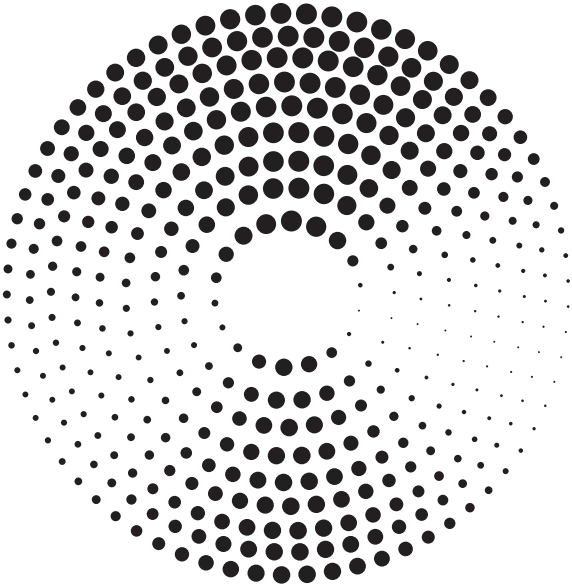
even envy, and that there would be so many synesthesia organizations in various countries all sharing knowledge. It's wonderful, and much thanks has to go to Richard Cytowic for daring to study it back then. I am just one of many whose life changed because of him.

We still have much to learn. While synesthesia appears to be well known, it is well known only in the rich countries. And while there are many famous people who are happy to share knowledge with the public that they are synesthetes, we have not yet reached synesthetes in countries that have fewer telecommunication resources. What do those in the third world countries know about synesthesia? Who are they? How do they use it, if they do? What do they have to tell us?

And here as well, many questions remain. We do not know the boundaries of synesthesia, meaning, if you have synesthesia, are you more likely to be left handed, have a superior memory, a poor sense of direction, be smarter than others, be inclined to want to pursue certain professions? We do not yet know the answers to any of these questions. In fact, new forms of synesthesia are still being discovered. And we have not really discovered why synesthesia exists in us at all.

There is still so much more work to be done. We are in the infancy of discoveries about synesthesia and I wonder what we will learn next. I hope knowledge of it will prove to be useful. I know some researchers who are trying to harness one sense to overcome a sensory deficit. Wouldn't it be wonderful if synesthesia could be used, for example, to help the blind to see? For synesthesia and synesthetes, this is a very exciting time.

Appendix



Moscow State University of Psychology and Education

МУЗЕЙ
МОСКВЫ

International Scientific Symposium

Synaesthesia: Cross-Sensory Aspects of Cognitive Activity across Science and Art

(Moscow, October 17–20, 2019)

in the framework of the 2nd International Conference of the *International Association of Synaesthetes, Artists and Scientists* (IASAS)

Poster of the Moscow Symposium. Design by Polina Varlashkina

Contents of the Appendix

Organisation and Programme Committees

Chairmen of the Organizing Committee

Vitaly V. Rubtsov, Dr., President of Moscow State University of Psychology & Education

Aleksandr S. Sokolov, Dr., Rector of Moscow Tchaikovsky State Conservatory

Deputy Chairmen of the Organizing Committee

Konstantin V. Zenkin, Dr., Vice-Chancellor for Scientific Work, Moscow Tchaikovsky State Conservatory

Arkady A. Margolis, Ph.D., Rector of the Moscow State University of Psychology and Education

The Organizing Committee

Sean A. Day, Ph.D., President of the International Association of Synesthetes, Artists, and Scientists (IASAS), Professor of Behavioral and Social Sciences, Trident Technical College, Charleston, South Carolina, USA

Konstantin V. Zenkin, Dr., Vice-Chancellor for Scientific Work, Moscow Tchaikovsky State Conservatory

Anton V. Sidoroff-Dorso, Board Member of IASAS, MPSU, Centre for Interdisciplinary Research of Contemporary Childhood at MSUPE, Moscow, Russia

James Wannerton, Vice-President IASAS, Stuttgart, Germany

Carolyn 'CC' Hart, Secretary of IASAS, San Francisco, CA, USA

Natalia A. Baykovskaya, Head of the International Relations Department of Moscow State University of Psychology and Education

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About the Organising Institutions

The Moscow State University of Psychology and Education (MSUPE) is a fast-developing, innovative institution of higher education. It was established in 1997 on the basis of the Psychological Institution of the Russian Academy of Education — the oldest psychological scientific institution. Psychological education at MSUPE originates in scientific works by the world-famous Russian scholars of psychology — Lev S. Vygotsky, Alexander R. Luria, and others. The scientific research foundation at MSUPE comprises public, scientific and education centres, including centres for neurophysiological, psychogenetic, and ethnopsychological research, and a high ability and cognitive resources research centre.

The Moscow State Tchaikovsky Conservatory was founded in 1866 by the pianist Nikolai Rubinstein, who became its first Director. Its first professors were famous musicians invited from abroad, as well as Pyotr I. Tchaikovsky, the world-renowned composer. His student, composer Sergei I. Taneyev, was also a Professor and then, for some time, Director of the Conservatory. Taneyev trained and educated Sergei Rachmaninoff, Aleksander Scriabin, and many others. The Conservatory grants Bachelor's and Master's degrees to composers, conductors, music theorists and performers. The Grand Hall of the Conservatory is one of the largest concert venues in the world and hosts performances by almost all of the most prominent musicians. Its scientific activities are implemented in various fields of theory and history of music, and are represented by such prominent scholars as Herman A. Laroche, Aleksei F. Losev, Boris V. Asafiev, and others. The Conservatory has several research centres for interdisciplinary study that, among other topics, focus not infrequently on synaesthesia and related issues.

The IASAS is a non-profit corporation, based in the United States, and operated exclusively for educational and charitable purposes. The IASAS's mission is to advance global awareness of the neurological

phenomena of synaesthesia, and to cultivate international collaboration among synaesthetes, artists, scientists, and other persons interested in synaesthesia. IASAS attempts to organize academic, educational and cultural events. Its previous conference in 2017 was hosted by the University of California, Los Angeles (UCLA); it brought in speakers and attendees from North and South America, Australia and New Zealand, and Asia, as well as from Europe.

We appreciated that scientists and artists experiencing and/or inspired by synaesthesia had the opportunity to contribute to the programme of the conference. We hope that our cooperation in organizing the conference in Moscow became the starting point for new joint projects among scientists, artists and synaesthetes and will result in wider interest in artistic and research projects related to synaesthesia, as well as open up new horizons for collaborations between Russian and foreign colleagues.

Greetings

Dear participants and guests of the International Congress "Synaesthesia: Cross-Sensory Aspects of Cognitive Activity in Science and Art",

It is with special pleasure that I note that the Moscow Conservatory was one of the organisers of this remarkable and undoubtedly innovative event that resulted from the tripartite agreement that the Conservatory signed with the Moscow State University of Psychology and Education and the International Association of Synaesthetes, Artists, and Scientists. Concerts that will take place during the days of the Congress in the Conservatory halls will become evidence of the profound and sometimes deeply hidden connections between music, gesture, colour, and a number of other phenomena, the range of which is much wider than we are used to thinking. That is why it is extremely important to continue the scientific study of synaesthesia, which can only be done by uniting specialists of various fields.

I wholeheartedly wish success attends the scientific symposium!

Alexander S. Sokolov
Merited Worker of the Arts Industry of the Russian Federation
President of the International Union of Musical Statesmen
Rector of Moscow State Tchaikovsky Conservatory
Doctor of Arts, Professor

Dear colleagues,

I am pleased to welcome the participants of the International Symposium "Synaesthesia: Cross-Sensory Aspects of Cognitive Activity across Science and Art".

The Moscow State University of Psychology and Education became one of the organisers of the symposium together with the Moscow Conservatory and the International Association of Synaesthetes, Artists, and Scientists.

During the days of the symposium, various workshops will take place at MSUPE and at the Moscow Conservatory, where we will discuss a wide range of issues on synaesthesia and intersensory aspects of cognitive activity in the fields of science, art and educational practices.

This is a unique event that will bring together leading scientists and practitioners in the field of synaesthesia as well as musicians and synaesthete artists.

We are pleased to welcome both Russian and many foreign participants to the symposium, representing unique research and creative projects within the scientific, practical and creative sections of the event.

I wish the participants of the symposium productive cooperation and exciting work.

Vitaly V. Rubtsov
Merited Worker of Science of the Russian Federation
Academician of the Russian Academy of Education
President of the Federation of Education Psychologists of Russia
President of Moscow State University of Psychology and Education
Doctor of Psychological Sciences, Professor

Dear reader,

The International Association of Synaesthetes, Artists, and Scientists (IASAS) was formed with some definite goals in mind. One was to be global, with board members from different countries and members from as many places as possible. The IASAS does indeed now have members from North and South America; Europe, Africa, Asia, Australia, and the South Pacific. These members include some of the top scientists in the world who do research on synaesthesia, and some of the most noteworthy synaesthete artists.

Another goal was that, rather than trying to grab the reins — and the members — from other organizations, our purpose would be to help organizations and groups interested in synaesthesia build themselves, and to help them contact, talk to and collaborate with other such organizations and groups. The IASAS 2019 Moscow conference has brought together a large number of different organizations, including the American Synesthesia Association, the International Foundation Arte Città, the Moscow State Tchaikovsky Conservatory, the Moscow State University of Psychology and Education, the Museum of Moscow, the UK Synaesthesia Association, and the Russian Synaesthesia Community.

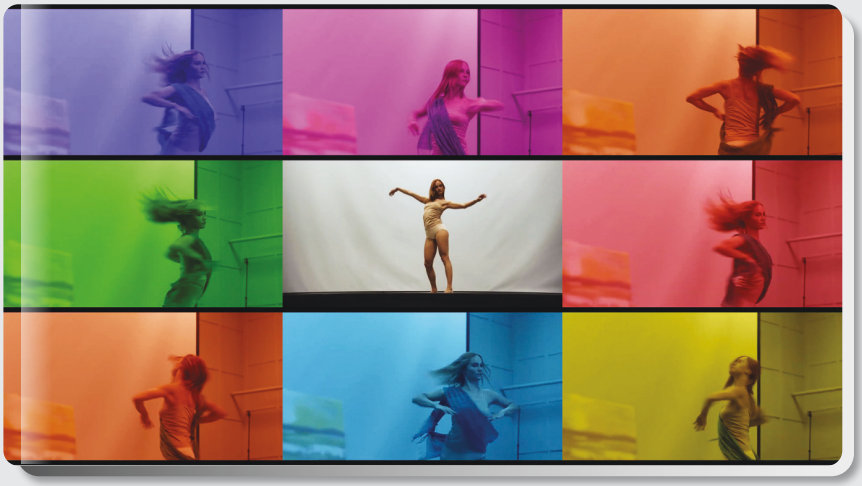
There is still a lot of confusion out there in the world regarding what synaesthesia is. For many, if they are familiar with the term "synaesthesia" at all, they are only familiar with it in terms of seeing colours for music, or perceiving colours for letters and numbers. Yet this is just a small tip of the iceberg of the over 80 different types of synaesthesia documented, and the dozens more that, although rare, might also potentially exist. One of the objects of this volume is to help you, the reader, to explore and discover the wide range that synaesthesia encompasses.

Towards this, in this volume, we have gathered together for you statements by some of these aforementioned leading scientists and artists, from around the world. These two groups do indeed overlap a little. You will quickly see that, as in any field where good scientific research is conducted, there are current debates, and differing views regarding specific points. Yet, likewise, you will also quickly see that we actually do know quite a lot, solidly, about synaesthesia, and are able to dispel a lot of the current prevalent inaccuracies and misconceptions. From the interviews with the artists, you will discover some of the wide range and diversity that synaesthesia can cover. Perhaps more importantly, however, you will see a small part of what living day-to-day life, over decades, with this trait is — and is not — like.

Thank you, dear reader, for being interested in this topic, and for becoming yet another person I could talk to and share wonder and fascination with. I hope to hear from you soon!

Sean A. Day, Ph.D.
President, IASAS

Panelists of the Moscow press conference from left to right: Sean A. Day, Elena V. Rovenko, Carol Steen, Jörg Jewanski, Carolyn 'CC' Hart, Kaitlyn Hova, Anton V. Sidoroff-Dorso. Photo: Sergey Kozmin



Around the World, Aroma and dance performance by Loliya Kasatkina (Kit Crew), Daria Fessalonika and Maria Zaslavskaya (Art Sensorium), frames from Olga Pankratova's documentary *Synaesthesia*

Wednesday, October 16

15:00–16:30, Press Conference

RIA Novosti Press Center, Presidential Hall
Host: Natalya Loseva, deputy editor-in-chief of RIA Novosti International News Agency

18:00–20:30, Public Opening, Public Lecture, Exhibition and Gala Concert Museum of Moscow

Panelists of the public lecture: Sean A.Day, Jörg Jewanski, Maura McDonnell, Carolyn 'CC' Hart, Kaitlyn Hova, Carol Steen, Richard E. Cytowic
Concert performers and presenters: Svetlana Rudenko and Maura McDonnell, Kaitlyn and Matt Hova, Christine Söffing, Loliya Kasatkina (Kit Crew), Daria Fessalonika and Maria Zaslavskaya (Art Sensorium), Christos Parapagidis, Ali Al-Ezzi
Concert host: Natalya Zakharova

Thursday, 17 October

MSUPE, Sretenka Street, 29

09:00–09:45, Participants registration

09:45–10:00, Official Opening

Ceremony Lecture Hall 506 (videostreaming in Room 505)
Welcome: Vitaly V. Rubtsov (MSUPE President), Konstantin V. Zenkin (Vice-Chancellor for Scientific Work, Moscow Tchaikovsky State Conservatory), Sean A. Day (President, IASAS), Anton V. Sidoroff-Dorso (IASAS International Coordinator)

10:00–11:40, Plenary 1: Keynote Speech and Guest Lecture

Lecture Hall 506 (videostreaming in Room 505), Moderators: Carolyn 'CC' Hart and Elena V. Rovenko
10:00–11:00, Richard E. Cytowic (George Washington Univ., Washington D.C., USA)

Synasthete musician Svetlana Rudenko is performing a music and visual piano piece at the Public Opening (Gala Concert) of the IASAS Mosow Conference. Museum of Moscow, October 16, 2019. Photo: Jörg Jewanski

Experimental musician, artist, art teacher and synaesthete Christine Söffing performing at the Public Opening (Gala Concert) of the IASAS Mosow Conference. October 16, 2019. Photo: Jörg Jewanski

Keynote Speech: Synesthesia: what do we know? What do we want to know?
11:00–11:30, Konstantin V. Zenkin (Vice-Chancellor for Scientific Work, at TMSC, Moscow, Russia)
Guest Lecture: The musical: its essence and place in art
11:30–11:40, Announcement of the symposium events

11:40–12:10, Poster Session

12:10–12:30, Break

12:30–14:00, Plenary 2: Synesthesia: Special Characteristics, Manifestation Forms and Some Benefits of the Phenomenon

Lecture Hall 506 (video streaming in Room 505), Moderator: Sean A. Day
12:30–13:00, Romke Rouw (University of Amsterdam, the Netherlands), What is 'special' about synesthesia?
13:00–13:30, Jamie Ward (University of Sussex, UK), Extreme synaesthesia
13:30–14:00, Beat Meier (University of Bern, Switzerland), Absolute pitch and sound-colour synaesthesia provide for unique learning opportunities

14:00–15:00, Lunch

15.00–16.45, Parallel Sections

Section 1-1: Synaesthesia and Higher Psychological Functions

Section 1-2: Synaesthesia and Developmental Children (Expert Round Table Talk)

Section 1-3: Research of Synaesthesia in Russia

Section 1-1: Synaesthesia and Higher Psychological Functions
Room 414, Moderator: Michael Haverkamp
15:00–15:35, Danko Nikolić (Frankfurt Institute for Advanced Studies, Germany), Ideasthesia: How it started and how it evolved?
15:35–16:10, Vera V. Dragileva (University of California, Berkeley, USA), Ideasthesia: a window into the workings of the brain
16:10–16:45, Svetlana I. Malakhova (Lomonosov Moscow State University, Russia), Synaesthesia as the higher mental function

Section 1-2: Synaesthesia and Developmental Children (Expert Round Table Talk). Room 412, Moderator: Romke Rouw

October 17, Thursday, Small Hall

International Association
of Synaesthetes, Artists and Scientists
and Moscow State University
of Psychology and Education

Concert Opening Ceremony
of the International Conference
SYNAESTHESIA
CROSS-SENSORY ASPECTS
OF COGNITIVE ACTIVITY IN
SCIENCE AND ART

Svetlana RUDENKO, piano (Ireland)

Kaitlyn HOVA, electro-violin (USA)

Yevgeniy STARODUBTSEV, piano

Experimental Orchestra
"The Flowers of Hell"

Artistic Director – Greg JARVIS
(Canada)

In the program:
S. Rachmaninoff, A. Scriabin,
M. Čiurlionis, G. Jarvis

Starts: 19:00
Bolshaya Nikitskaya St., 13

Svetlana Rudenko and Geraldine Hahn are giving a talk accompanied by a music performance. Photo: Jörg Jewanski

15:00–15:40, Olga V. Rubtsova (Head of the Centre for Cross-Disciplinary research of Contemporary Childhood, MSUPE, Moscow, Russia), Synaesthete children: Support information for parents and educational institutions
15:20–15:40, Anton V. Sidoroff-Dorso (Moscow State Pedagogical University, Russia), Results of research of children with congenital synaesthesia
15:40–16:45, Experts (Richard Cytowic, Jamie Ward, Christine Söffing): Questions and answers

Section 1-3: Research of Synaesthesia in Russia
Room 311, Moderator: Marina A. Iosifyan
15:00–15:35, Elena A. Lupenko (MSUPE, Moscow, Russia), Synaesthesia: A phenomenon or cognitive mechanism?
15:35–16:10, Anastasia S. Malyshevskaya (National Research University "Higher School of Economics", Moscow), Spatial mapping of temporary semantics
16:10–16:45, Dmitry A. Nedil'ko (MSUPE, Moscow, Russia), Empathy and emotional intelligence in individuals with congenital synaesthesia

16:45–19:00, Break

19:00–20:30, Concert Programme with Elements of Lecture Talks

Conservatory, Small Hall, Bolshaya Nikitskaya Street, 13/6
Svetlana Rudenko (University of Granada, Spain), Geraldine Hahn (Graphic Arts Advisors, Mountain Lakes, NJ, USA) and Maura McDonnell (Trinity College, Dublin, Ireland): Cognitive musicology: Visuals for classical music via cross-modal associations of musical texture
Johannes Brahms, Intermezzo op.117, No. 2, accompanied by projecting paintings by Timothy B. Layden
Sergei Rachmaninoff, Préludes op. 32, accompanied by a video of paintings by Ninghui Xiong
Alexander Scriabin, Poems op. 71, accompanied by video projection of paintings by Esther McMahon
Svetlana Rudenko, Dance of Textures, with Ann LePore's 3D animation Geraldine Hahn's art works.
Kaitlyn Hova (violin) and Matt Hova (Women Who Code, San Francisco, CA, USA): Light-emitting synaesthetic violin 'Hovalin'
Kaitlyn Hova, Such Bright Lights
Benj Pasek and Justin Paul, A Million Dreams, Never Enough (OST The Greatest Showman)

Upper: Kaitlyn Hova is playing the light-emitting Hovalin.
Middle: Yevgniy Starodubtsev is performing *Storms and Depths* by Mikolajus Čiurlionis.
Below: *The Flowers of Hell* are performing Symphony No. 1.
Photos: Jörg Jewanski

Yevgniy Starodubtsev (piano): Mikolajus Čiurlionis, Storms and Depths, 8 piano pieces, accompanied by projected visuals Prelude. Fugue by Čiurlionis *The Flowers of Hell* (Greg Jarvis, Daniella Friesen, Sean M. Berry, Stephen Head, Ian E. Thorn): Greg Jarvis, Symphony No. 1

Friday, 18 October

MSUPE, Sretenka Street 29

09:30–12:00, Plenary 3: Synaesthesia: Exploring the Related Individual Difference in Science and Art

Lecture Hall 506 (videostreaming in Room 505),
Moderator: Michael Haverkamp
09:30–10:30, Michael Banissy (University of London, UK)
Keynote Lecture: Sharing the experiences of others: Understanding mirror-sensory synaesthesia
10:30–11:00, Anton V. Sidoroff-Dorso (Moscow Pedagogical State University, Russia), Grapheme-colour synaesthesia in the structure of individuality: research results
11:00–11:15, Jörg Jewanski (University of Vienna, Austria), Announcement of the 2020 Vienna conference, in collaboration with the IASAS and with artecittà
11:15–12:00 Sean A. Day (IASAS President, Trident Technical College, USA) and James Wannerton (IASAS Vice-President, UK), 'What if': or, Future experiments I'd like to see

12:00–12:30, Break

12:30–14:15, Parallel Sections

Section 2-1-1: Synaesthetic Foundations of Design

Section 2-1-2: Synaesthesia: First-Person Point of View

Section 2-1-1: Synaesthetic Foundations of Design
Room 414, Moderator: Sean A. Day
12:30–13:05, Dina Riccò (Politecnico di Milano, Italy), Synaesthetic qualities of the images: a study with iconic images in weak synaesthetic subjects (via teleconferencing)
13:05–13:40, Michael Haverkamp (Cologne, Germany), Synaesthetic design versus multisensory design — differences and benefits

13:40–14:15, Svetlana L. Belykh (Moscow Economic Institute, Russia) and Elena L. Rukavishnikova (Moscow Agricultural Timiryazev Academy, Russia), Aesthetic preferences for landscape design styles depending on the success of tactile and visual transition

Section 2-1-2: Synaesthesia: First-Person Point of View
Room 412, Moderator: Michael Banissy
12:30–13:05, Carolyn 'CC' Hart (LMT, San Francisco CA, USA) and Lidell Simpson (Brogaard Lab for Multisensory Research, University of Miami, Miami, FL, USA), By the Sword: Synaesthesia and the art of the duel
13:05–13:40, Lidell Simpson (Brogaard Lab for Multisensory Research, University of Miami, FL, USA), A taste of Moscow
13:40–14:15, Efstratia Zografou-Elgabry (Effie Elgabry) (ACS — Institute of Innovation and Creativity, Athens, Greece), Personal account of synaesthesia

14:15–15:20, Lunch

15:20–17:00, Parallel Sections

Section 2-2-1: Synaesthesia — the Universal and the Individual

Section 2-2-2: History of Synaesthesia Research

Section 2-2-1: Synaesthesia — the Universal and the Individual
Room 414, Moderator: Larisa P. Prokofieva
15:20–15:55, Carol Steen (Touro College and University System, New York, NY, USA), Synesthetic photisms and hypnagogic visions: a comparison
15:55–16:30, Jasmin Sinha (University of Luxembourg, Esch-sur-Alzette, Luxembourg), Sneaking in through the backdoor: A case of unexpected synaesthesia
16:30–17:00, Ann LePore (Ramapo College of New Jersey, USA), Translating Between Synaesthetes: Art Picks Up Where Language Leaves Off

Section 2-2-2: History of Synaesthesia Research
Room 412, Moderator: Polina Dimova
15:20–15:55, Jörg Jewanski (University of Vienna, Austria) and Anton Sidoroff-Dorso (Moscow Pedagogical State University, Russia), A small piece of jewelry. The first congress on 'synesthesia': Saint Petersburg 1742
15:55–16:30, Jörg Jewanski (University of Vienna, Austria), Rustem Sakhabiev (Münster, Germany) and Anastasia B. Maksimova (Prometheus Insitute, Kazan', Russia), 18 synesthesia congresses at the

'Prometheus' in Kazan': 1967–2015. Presentation of a book
16:30–17:00, Jörg Jewanski (University of Vienna, Austria) and Christoph Reuter (University of Vienna, Austria), About blue flutes and red trumpets. Features and tendencies of timbre-color mappings

Saturday, 19 October

Moscow Tchaikovsky State Conservatory, Bolshaya Nikitskaya Street, 13/6

During the whole day

- Exhibition of paintings
- Aroma paintings Art Sensorium
- Interactive installation *Music Bench*, platform Playtronica
- Screening of films, TV programs and videos: Martin Schloesser (Documentary *Synaesthesia — Extraordinary Normal*), Yulia Kiselyova (Documentary *Brain. Another Universe*), Samantha Moore (*An Eyeful of Sounds*), Yevgeniya Oliyarnik and Yana Varlashkina (TV-Channel Nauka (Science), Carol Steen and Greta Berman (video *Synaesthesia and Art*)
- Interactive multi-sensory installation *Synaesthesia: Solomon's Case* by Christos Parapagidis

10:00–11:30, Plenary 4: Methodological Foundations of synaesthesia research in Linguistics, Aesthetics and Pedagogy

1st Study Building (Building of the Small Hall, Floor, 2, Room 21), Moderator: Konstantin V. Zenkin
10:00–10:30, Larisa P. Prokofieva (Saratov State Vasily I. Razumovsky Medical University, Russia), Synaesthesia — Synaesthemia — Intersensory association: Report on the methodology of psycholinguistic research
10:30–11:00, Svetlana V. Konanchuk (St. Petersburg State Institute of Psychology and Social Work, Russia), Exploring synaesthesia in aesthetics
11:00–11:30, Nina A. Nikolaeva (St. Petersburg Rimsky-Korsakov State Conservatory, Russia), The historical aspect of the study of synesthesia in the example of the pedagogical concepts of Jan Amos Komensky

11:30–12:00, Break

12:00–14:20, Parallel Sections

Section 3-1-1: Synaesthesia and Cross-Sensory Aspects of Cognition in Comparative Literature and Musicology

Section 3-1-2: Synaesthesia and Cross-Sensory Aspects of Cognition in Techniques for Correction and Development

Section 3-1-3: Synaesthetic Aspects in Screen Arts and Digital Technology

Section 3-1-1: Synaesthesia and Cross-Sensory Aspects of Cognition in Comparative Literature and Musicology
1st Study Building, Building of the Small Hall, Floor 2, Room 21, Moderator: Larisa P. Prokofieva
12:00–12:35, Nina P. Kolyadenko (Novosibirsk Mikhail I. Glinka State Conservatory, Russia), Synaesthetic picture of the world in the works of Andrey Bely
12:35–13:10, Svetlana N. Loseva (Irkutsk State University, Russia), Synaesthetics in the structure of Anatoliy Teplyakov's musical talent
13:10–13:45, Yevgenia A. Yelina (Saratov State Law Academy, Russia) and Olga V. Agapova (Moscow Higher Combined-Arms Command School, Russia), Russian and French art discourse from the synaesthesia perspective
13:45–14:20, Polina Yaroshenko (Moscow State University, Russia), The translation models for verbalized synaesthetic associations (a case study of the French and Russian languages)

Section 3-1-2: Synaesthesia and Cross-sensory Aspects of Cognition in Techniques for Correction and Development
1st Study Building, Building of the Small Hall, Floor 2, Room 23, Moderator: Christine Söffing
12:00–12:35, Amy Neilson Smith (self-employed artist, UK), How can developing 'Tasting Colour' pedagogical practises, sensorial dialogic narrative and multisensory performance and design, combining the crossmodally of synaesthesia and tasted-based poetics, empower vision impaired students by creating an inclusive and metaphorical perception of colour?
12:35–13:10, Sonia T. Canton, Juan García Villar, and María José de Córdoba Serrano (University of Granada, Spain, and International Foundation Artecittà, Spain), Synaesthesia, emotion and creativity: approximation to the comparative study between students of different ages and educational stages with students with intellectual disability.
13:10–13:45, Oleg A. Guzeyev (Donmet NGO, Donetsk, Russia), Set for the prevention of dyscalculia in children: intersensory aspect

Section 3-1-3: Synaesthetic Aspects in Screen Arts and Digital Technology
Conference Hall, Moderator: Kaitlyn Hova
12:00–12:35, Marina Iosifyan (Moscow State University, Russia), Sensory aspects of cinematic art: cross-fashion associations and film aesthetics
12:35–13:10, Svetlana E. Lotsmanova (Academy of Media Industry, Moscow, Russia), Film installation as an object of a synthetic form of sensory perception
13:10–13:45, Kenny McAlpine and Solange Glasser (Melbourne Conservatorium of Music, Australia), Synthesising Synaesthesia: Algorithmic synaesthesia in virtual and augmented realities

14:20–15:20, Lunch

15:20–17:20, Parallel Sections

Section 3-2-1: Synaesthesia, Olfaction, Art

Section 3-2-2: Synaesthetic Body — Image, Movement and Gesture

Section 3-2-3: Synaesthesia and Making Art

Section 3-2-1: Synaesthesia, Olfaction, Art
1st Study Building, Building of the Small Hall, Floor 2, Room 21, Moderator: Romke Rouw
15:20–15:55, Jingyi Li and María José de Córdoba Serrano (University of Granada, Spain), A case of olfactory somatosensory response
15:55–16:30, Daria Fessalonika (Moscow, Russia), Olfactory-color synesthesia in art: colored sense of smell
16:30–17:05, Christine Söffing (EMU-Ensemble, Center for Music & Art, University of Ulm, Germany), The Yellow Dotted Scent. Synaesthesia as an artistic tool to create scent-compositions and scent-sound-installations

Section 3-2-2: Synaesthetic Body — Image, Movement and Gesture
1st Study Building, Building of the Small Hall, Floor 2, Room 23, Moderator: Polina Dimova
15:20–15:55, Jinglin Zhang (Chengdu, Sichuan, China), Fashion design inspired by Mozart
15:55–16:30, Svetlana Y. Lysenko (Khabarovsk State Institute of Culture, Russia), Choreographic interpretation of *Boléro* by Maurice Ravel in modern musical theatre: experience of synaesthetic analysis
16:30–17:05, Tatiana V. Kozlova (Russian State Specialized Academy of Arts, Moscow), Synaesthesia and sign language features in artistic and aesthetic activities

Section 3-2-3: Synaesthesia and Making Art
Conference Hall, Moderator: Carolyn 'CC' Hart
15:20–15:55, Marina Linares (Freie Akademie der Bildenden Künste, Essen, Germany), Wassily Kandinsky: Synaesthetic artist or synaesthetic art?
15:55–16:30, Carrie C. Firman (Edgewood College, Madison, Wisconsin, USA), Creative License and Synesthesia: The Roles of Expressive and Exacting Art Work
16:30–17:05, Heather Aldridge (Los Angeles, CA, USA), Coming to my senses: How a writer harnesses her synesthesia

20:00, Conference Dinner

Sunday, 20 October

Moscow Tchaikovsky State Conservatory, Great Nikita Street, 13/6

During the whole day

- Exhibition of paintings
- Aroma paintings Art Sensorium
- Interactive installation Music Bench, platform Playtronica
- Screening of films, TV programs and videos: Martin Schloesser (Documentary Synaesthesia – Extraordinary Normal), Yulia Kiselyova (Documentary Brain. Another Universe), Samantha Moore (An Eyeful of Sounds), Yevgeniya Oliyarnik and Yana Varlashkina (TV-Channel Nauka (Science), Carol Steen and Greta Berman (video Synesthesia and Art)
- Interactive multi-sensory installation Synesthesia: Solomon's Case by Christos Parapagidis

10:00–11:30, Plenary 5: Synaesthesia in Music Education and Musicology

1st Study Building, Building of the Small Hall, Floor 2, Room 21, Moderator: Polina Dimova
10:00–10:30, Marina V. Karaseva (Moscow State Tchaikovsky Conservatory, Russia), Synaesthesia in the service of the technique of musical hearing education and artistic psycho-correction
10:30–11:00, Elena V. Rovenko (Moscow State Tchaikovsky Conservatory, Russia), 'Wagnerian painting' and the phenomenon of synaesthesia

11:00–11:30, Marina S. Starcheus (Moscow State Tchaikovsky Conservatory, Russia), Color hearing as a subject of interdisciplinary research

11:30–12:00, Break

12:00–13:45, Parallel Sections

Section 4-1-1: Synaesthesia and Cross-Sensory Aspects in Music Cognition and Aesthetics

Section 4-1-2: Synaesthesia and Music — Education Techniques and Talent Development

Section 4-1-3, Synaesthetic Imagery in Child Music Education

Section 4-1-4: Synaesthesia in Music Visualisation: Historical Perspectives

Section 4-1-1: Synaesthesia and Cross-Sensory Aspects in Music Cognition and Aesthetics
1st Study Building, Building of the Small Hall, Floor 2, Room 21, Moderator: Elena V. Rovenko
12:00–12:35, Svetlana Rudenko and Maura McDonnell (Trinity College Dublin, UK), Cognitive Musicology via Synaesthesia & Cross-modal Associations: Scriabin Sonata No. 5 op. 53
12:35–13:10, Marina L. Zaitseva (Russian State Kosygin University, Moscow), Features of synaesthesia in the epistolary heritage of romantic composers
13:10–13:45, Leonid G. Aleksandrov (Chelyabinsk State University, Russia), The concept of the 'synthetic man' in the aesthetics of Vladimir F. Odoyevski

Section 4-1-2: Synaesthesia and Music — Education Techniques and Talent Development
1st Study Building, Building of the Small Hall, Floor 2, Room 23, Moderator: Sean A. Day
12:00–12:35, Eduardo Sola (Burman University, Lacombe, Alberta, Canada), Music notation → colour synesthesia: an alternative approach to teaching music to synesthetes
12:35–13:10, Umut Eldem (Royal Conservatoire, Antwerp, Belgium), Beyond the pitch: Applying synaesthetic principles to the musical practice
13:10–13:45, Solange Glasser (The Melbourne Conservatorium of Music, University of Melbourne, Australia), The tip of the iceberg: redefining absolute pitch through the lens of synaesthesia

Section 4-1-3, Synaesthetic Imagery in Child Music Education
Conference Hall, Moderator: Elena A. Lupenko
12:00–12:35, Nina V. Morozova (Perm State Humanities and Educational University, Russia), A study of polymodal intersensory figurative means of musical and educational communication
12:35–13:10, Elena S. Tapilina and Natalya G. Tapilina (Municipal Budget Institution of Culture of Additional Education "Yekaterinburg Children's School of Arts No. 9", Russia), Priority features of the formation of synaesthesia perception: on the example of the work of the Yekaterinburg Children's School of Art No. 9 and the Sverdlovsk Ivan D. Shadr Art School
13:10–13:45, Olga V. Mizyurkina (Novosibirsk State Philharmonic, Russia), Synaesthetic films in the study of Igar Stravinsky's *Rite of Spring* in children's music schools and children's art schools

Section 4-1-4: Synaesthesia in Music Visualisation: Historical Perspectives
1st Study Building, Building of the Small Hall, Floor 1, Room 9, Moderator: Romke Rouw
12:00–12:35, Polina Dimova (University of Denver, CO, USA), The color of music: Twenty theses on synaesthesia
12:35–13:10, Yaroslav A. Bezokov (Novosibirsk, Russia), The ratio of stress levels as a method of forming synesthetic sensations in light music
13:10–13:45, Ludmila V. Leipson (Freie Waldorfschule Flensburg, Germany), The idea of visualizing sound in Rudolf Steiner's Eurythmics

13:45–15:00, Lunch

15:00–17:00, Roundtable/ Discussion / Announcement

1st Study Building, Building of the Small Hall, Floor 2, Room 21
Hosts: Sean A. Day and Elena V. Rovenko
Speakers: Jörg Jewanski, Marina L. Zaitseva, Svetlana Rudenko, Marina Linares, Carolyn 'CC' Hart, Nina V. Morozova, Polina Dimova, Anton V. Sidoroff-Dorso, Ludmila V. Leipson
Participants: Abiola Olaniyi Ogunsanwo, Julia López de la Torre Lucha, Eleni Zografou, Cécile Meier, Ali Al-Ezzi, Scott Bailey, Timothy Crandle, Annika Johnson, Carter Jones, Jacqueline Knaier, Mark Knaier, Greg Jarvis, Daniella Friesen, and others.
Announcement: Jörg Jewanski (University of Vienna, Austria), Announcement of the 2020 Vienna conference in collaboration with the IASAS and with artecittà

17:00–19:00, Break

19:00, Concert Programme / Closing Ceremony

Moscow Tchaikovsky State Conservatory, Great Nikita Street, 13/6, Rachmaninoff Hall
Neurotech Lab (Saint Petersburg Institute of Interdisciplinary Research), Grigory Korolyov (synaesthete, piano) and Yevgeniy Starodubtsev (non-synaesthete, piano): Olivier Messiaen, *Amen de la Consommation*, a piano piece from the suite *Visions de l'Amen*, EEG-Suite: experimental, scientific and musical performance (musical performance, listening activity, and lab-like EEG registration on synaesthetes vs. non-synaesthetes); Concept and arrangement: Anton V. Sidoroff-Dorso

Playtronica and Anno Domini Quartet: Gennadiy Akinfin (violin), Mikhail Akinfin (violin), Aleksandra Zhelvakova (alto), Ekaterina Modina (cello): Philip Glass, String Quartet No. 3 (OST 'Mishima'), performance on experimental electronic instruments accompanied by academic music performance

Peter Theremin (theremin) and Korolëv Orchestra (directed and conducted by Grigory Korolyov): Bohuslav Martinů, *Fantasia* for Theremin, Oboe, String Quartet and Piano, H. 301

Playtronica and Korolëv Orchestra (directed and conducted by Grigory Korolyov): Steve Reich, *Eight Lines,* performance on experimental electro-instruments accompanied by academic music performance

Peter Theremin (theremin) and Korolëv Orchestra (directed and conducted by Grigory Korolyov): Joseph Schillinger, *First Airphonic Suite* for Theremin and Orchestra op. 21

Yulia Migunova (cello): Nikolay Popov, *KCl_23/11* for Cello, Electronics and Video, Video Dmitry Maturov, VIVLabz production

Sergey Poltavsky (electric violin), Andrey Vinnitskiy (percussion), Nikolai Popov (electronics), and Igor Kefalidi (electronics): Igor Kefalidi, *Some_Small_Synth* for Acoustic and Electronic Sounds, Visuals by Aleksandr Pettay.


20
ВОСКРЕСЕНЬЕ
ОКТЯБРЯ
РАХМАНИНОВСКИЙ ЗАЛ
МЕЖДУНАРОДНАЯ АССОЦИАЦИЯ СИНЕСТЕТОВ, ДЕЯТЕЛЕЙ ИСКУССТВА И НАУКИ
МОСКОВСКИЙ ГОСУДАРСТВЕННЫЙ ПСИХОЛОГО-ПЕДАГОГИЧЕСКИЙ УНИВЕРСИТЕТ
КОНЦЕРТ-ЗАКРЫТИЕ
МЕЖДУНАРОДНОЙ КОНФЕРЕНЦИИ
СИНЕСТЕЗИЯ
МЕЖСЕНСОРНЫЕ АСПЕКТЫ ПОЗНАВАТЕЛЬНОЙ ДЕЯТЕЛЬНОСТИ
В НАУКЕ И ИСКУССТВЕ
Платформа «PLAYTRONICA»
Пётр ТЕРМЕН терменвокс
Квартет «ANNO DOMINI»:
Геннадий АКИНФИН скрипка
Михаил АКИНФИН скрипка
Александра ЖЕЛВАКОВА альт
Екатерина МОДИНА виолончель
Евгений СТАРОДУБЦЕВ фортепиано
Юлия МИГУНОВА виолончель
Сергей ПОЛТАВСКИЙ электроскрипка
Андрей ВИННИЦКИЙ ударные
Николай ПОПОВ электроника
Игорь КЕФАЛИДИ электроника
КАМЕРНЫЙ ОРКЕСТР
«KOROLËV ORCHESTRA»
Художественный руководитель и дирижёр –
Григорий КОРОЛЁВ
В КОНЦЕРТЕ ПРИНИМАЮТ УЧАСТИЕ:
Алёна БАРАМИДЗЕ флейта
Анастасия ЯРОСЛАВЦЕВА флейта
Мария ШАРПИЛО гобой
Дарья ВЕРШИНИНА кларнет
Александр ФУРСОВ кларнет
Дмитрий АКИНФИН скрипка
Ольга ЧЕРНОГОРОВА скрипка
Екатерина ШАРАПОВА альт
Александра ЛОТОВА фортепиано
В ПРОГРАММЕ:
С. Рахманинов, А. Скрябин, М. Чюрлёнис, Г. Джарвис
НАЧАЛО 19:00 | АДРЕС: Б. НИКИТСКАЯ, 11 | 495 629-9168 | БИЛЕТЫ В КАССАХ МГК 6+
БРОНИРОВАНИЕ 495 695-8905 13:00-21:00 | ЭЛЕКТРОННАЯ ПРОДАЖА: WWW.MOSCONSV.RU
СЕЗОН 2019-2020
СБЕРБАНК
SIEMENS
METRO

Grigory Korolyov (synaesthete, piano) and Yevgeniy Starodubtsev (nonsynaesthete, piano) are performing synaesthete composer Olivier Messiaen's piece *Amen de la Consommation* while their brain activity is being registered via EEG. Concept and arrangement: Anton V. Sidoroff-Dorso. Frame from Olga Pankratova's documentary *Synaesthesia*

Grigory Korolyov and Aleksandra Markevich in their EEG setup, ready to perform synaesthetic composer Olivier Messiaen's *Amen de la Consommation*. Frame from Olga Pankratova's documentary *Synaesthesia*

October 20, Thursday
Rachmaninoff Hall
International Association
of Synaesthetes, Artists and Scientists
and Moscow State University
of Psychology and Education
Concert Closing Ceremony
of the International Conference
SYNAESTHESIA
INTERSENSORY ASPECTS OF
COGNITIVE ACTIVITY IN SCIENCE AND ART
PLAYTRONICA platform
Peter THEREMIN (theremin)
ANNO DOMINI Quartet
Gennadiy AKINFIN (violin)
Mikhail AKINFIN (violin)
Aleksandra ZHELVAKOVA (alto)
Ekaterina MODINA (cello)
Yevgeniy STARODUBTSEV (piano)
Yulia MIGUNOVA (cello)
Sergey POLTAVSKIY (electric violin)
Andrey VINNITSKIY (percussion)
Nikolay POPOV (electronics)
Igor KEFALIDI (electronics)
CHAMBER ORCHESTRA
"KOROLËV ORCHESTRA"
Artistic director and conductor
Grigory KOROLYOV
Musicians of the orchestra:
Alyona BARAMIDZE (flute)
Anastasia YAROSLAVTSEVA (flute)
Maria SHARPILO (oboe)
Darya VERSHININA (clarinet)
Aleksandr FURSOV (clarinet)
Dmitriy AKINFIN (violin)
Olga CHERNOGOROVA (violin)
Yekaterina SHARAPOVA (alto)
Aleksandra LOTOVA (piano)
In the program:
S. Rachmaninoff, A. Scriabin,
M. Čiurlionis, G. Jarvis
Starts: 19:00
Bolshaya Nikitskaya St., 13

Some works on display at the Museum of Moscow, October 16.
Photo: Yanina Skorobogatova

Volunteer students are arranging the exhibition at Moscow State University of Psychology and Education, October 17

Exhibition: Artists and Artworks

Ali Al-Ezzi (Iran)
Forgotten Promises, oil colours on canvas, 60×80 cm, 2016

María José de Córdoba Serrano (Spain)
Protecion, super-alpha paper 38×50 cm; crystallized polystyrene plate: 20×20 cm, intaglio engraving on synthetic polymers, 2003
Desiero 1", mixed media on canvas, 100×88 cm, 2017
Sonido del Silencio, mixed media on tablex, 50×50 cm, 2018

Carrie Firman (USA)
That Which Cannot Be Said with Words, series of digital photographs, dye sublimation on metal, 2010–present

Appelusa Fleming-McGLynn (USA)
Blue Door, photograph on paper, 61×91.5 cm, 2017

Geraldine Hahn (USA)
8-Bit Chiptunes, linen and cotton on linen, cotton and metallic thread and floss, 60×50 cm, 2017
And, But, and Not triptych, silk, cotton, poly ribbon, metallic and cotton thread and floss, each of the three is 75×75 cm, 2018

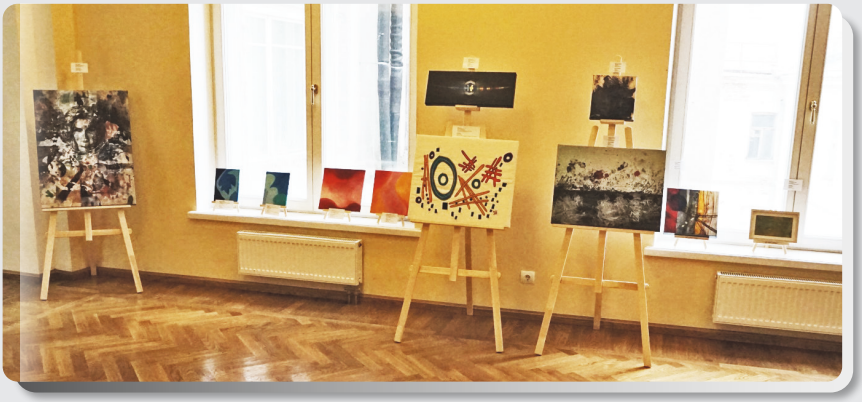
Carolyn 'CC' Hart (USA)
Castor, dye sublimation on metal, 40.5×20 cm, 2019

Michael Haverkamp (Germany)
Polyphonic aggregation, acrylic on cardboard, 30×30 cm, 2019
Polyphonic aggregation, acrylic on cardboard, 30×30 cm, 2019
Fortissimo I, acrylic on cardboard, 30×30 cm, 2019
Upturn, acrylic on cardboard, 10×20 cm, 2019
Silent End, acrylic on cardboard, 19×19 cm, 2019
Wagner Motifs, acrylic on cardboard, 24×18 cm, 2019
dsch, print on paper, 30×42 cm, 2019

Dillon James (USA)
Broadway in the Rain, oil on canvas, 61×122 cm, 2012

Timothy B. Layden (UK)
Valentina Tereshcova, mixed media on paper, 86×63 cm, 2016

Yanina Skorobogatova and Yana Krivosheyeva (Russia)
Being Born Blind, digital photo collage, 60×60 cm, 2017
The Breath of Flowing Moonlight, digital photo collage, 60×60 cm, 2017 (2019)



View of the exhibition at the Moscow Conservatory. Photo: Jörg Jewanski

Marcia Smilack (USA)
Mostly Eyes, photograph on paper, 2000

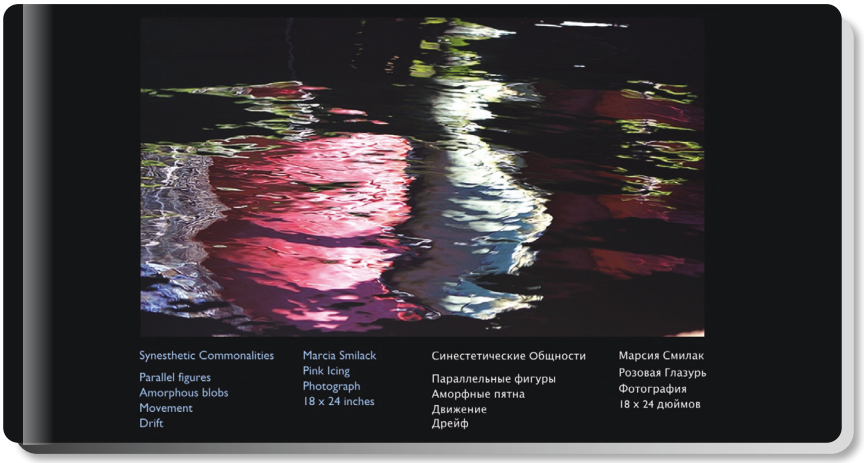
Christine Söffing (Germany)
Alexander László's Sonatina op. 11, 1 and 2, oil on canvas, 20×30 cm, 2003
Red Sounds, 1 and 2, oil on canvas, 30×30 cm, 2003

Carol Steen (USA)
Water Blue, oil on paper, 22×13 cm, 2003
Hypnagogic Images, digital video-installation, 2014–2019, slides: 2019

Polina Varlashkina (Russia)
No title, oil on canvas, 120×100 cm, 2018

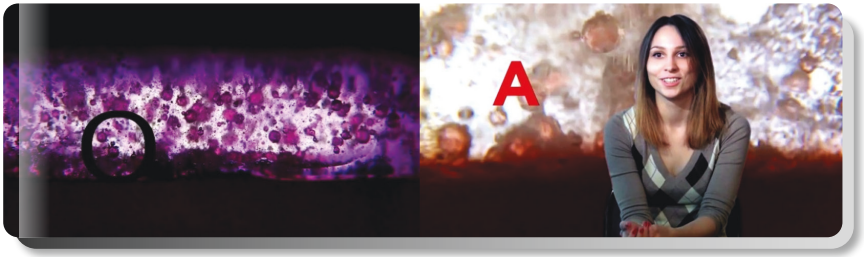
James Wannerton (UK)
Tastes of London, digital print to aluminum, 122×178 cm, 1964–2013

Ninghui Xiong (China)
One of the Big Waterfalls, oil on canvas, 101×80.5 cm, 2001–2002



Carol Steen and Greta Berman, *Synesthesia and Art*

Synesthesia and Art (2019, 28 min.) showcases a number of synesthetic artists who literally perceive the world differently. Its aim is to explore both synesthesia and hypnogogia, in an effort to bring about a new and intense way of looking and challenge existing assumptions. Observations in this video are supported both by neuroscience and by actual experiences. *Synesthesia and Art* was created jointly by Carol Steen, a synesthetic artist, and researcher, and Greta Berman, an art historian who has extensively studied the phenomenon. The Kluver animations were created by Chad Sikora and Carol Steen, and the translation into Russian was provided by Lora Gornaya



Yulia Kiselyova, Brian. *Another Universe*

A 13-minute episode on synaesthesia from Yulia Kiselyova's science documentary *Brain. Another Universe* (2017). The excerpt describes synaesthetes' experience through animation, interviews and expert opinion

Martin Schlösser, *Synesthesia — Extraordinary Normal*

Synesthesia — Extraordinary Normal (2019, 30 min.). Short documentation; director/camera: Martin Schlösser interview partners: Birgit Böhm, Caroline Beier, Jasmin Sinha, Katja Krüger. Synesthetes explain in interviews their different types of this phenomenon. Animations visualize their personal perceptions and sound effects emphasize the auditive impact. As synaesthetic perceptions are subjective, it's difficult to share them with outsiders, who cannot distinguish synaesthesia from their own experience, and find it hard to comprehend how the impressions influence them

Yevgeniya Oliyarnik, *Synaesthesia: Extra ability*

Synaesthesia: Extra ability. A series of two TV episodes made in 2016–2017 by Yevgeniya Oliyarnik (director) and Yana Varlashkina (scriptwriter). Produced by Kanal Nauka (Science TV Channel). The project involved several people with congenital synaesthesia and presented them with individual challenges testing their memory, attention, imagination and music abilities. Psychologists, music theorists, and physiologists were invited as a jury board to pass their professional judgement

Samantha Moore, *An Eyeful of Sound*

An Eyeful of Sound (10 min.), animated documentary about audio-visual synaesthesia. It is directed by Samantha Moore, produced by Joshka Wessels at Sapiens Productions and the scientific advisor is Jamie Ward (University of Sussex, UK). A selection of everyday sounds as described by synaesthetes were impressionistically animated together with the sound that inspired them

Playtronica, *Sonic Bench*

Sonic Bench (2018) by Playtronica in collaboration with Yauza. The installation gives participants an opportunity to feel the sound of their touch. *Sonic Bench* is an interactive audio installation that turns human touch into sound and music. Sit back, relax and feel your partner's hand. Create interactive experiences through touch, technology, and sound. Build using TouchMe device from Playtronica. In the photo: Jasmin Sinha is playing the *Sonic Bench*

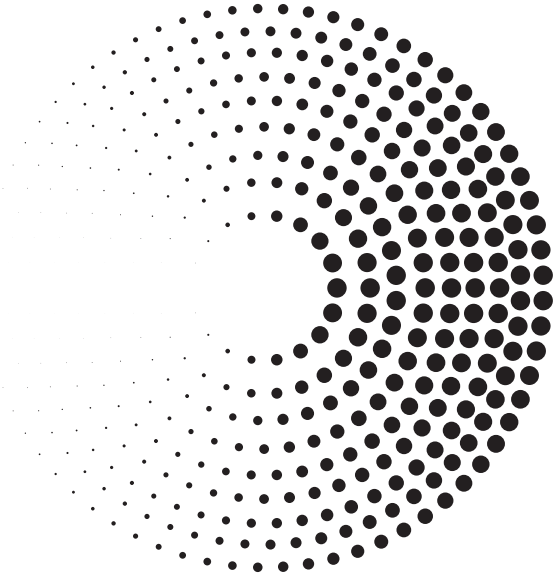
Art Sensorium, *Aroma paintings*

Aroma paintings by Art Sensorium, a duet of perfumer and olfactory expert Daria Fessalonika and artist Maria Zaslavskaya. A collection of fragrances (2019) is dedicated to authentic cultures and distant countries. Each of the six perfumes is accompanied by a painting to reinforce tactile and chromatic associations. Art Sensorium is a synaesthetic collection of images and fragrances designed to involve the viewers through multisensory imagination. Photo: Jörg Jewanski

mastroKristo, *Synaesthesia: Solomon's Case*

Synaesthesia: Solomon's Case (2016), created by mastroKristo (Christos Parapagidis). Through the 27-minute interactive multisensory installation, the artist invites the spectators to get familiar with the phenomenon of synaesthesia and the unique way in which the famous Russian synaesthete Solomon V. Shereshevsky perceived the world. Shereshevsky's bizarre and inspiring synaesthetic descriptions of six numbers were the motivation for the artist to compose six musical themes and create six digital living paintings. In front of them, the participants have an interactive wood carved panel which includes six perfumes and six beverages. During the screenings, light indications guide them to taste and to smell. As a result of this procedure, visitors taste, smell, hear, watch and touch at the same time, technically approaching Shereshevsky's 5-fold synaesthesia. mastroKristo uses tactile mediums and combines the craft of woodworking and woodcarving with music creation and sound processing, in order to create visually or aurally affecting hybrids, blurring the lines between visual arts, sound, technology, and personal experience, https://mastrokristo.wixsite.com/website

Name Index



Name Index

The pages numbers of the interviews are marked in bold.

Synaesthesia: Opinions and Perspectives

Anton V. Sidoroff-Dorso, Sean A. Day, and Jörg Jewanski (Eds.)

Synaesthesia is a remarkable phenomenon: It unites scientists and artists, as well as different disciplines such as neuroscience, psychology, music, art, philosophy and linguistics. This book is a collection of interviews with scientists and artists who explore synaesthesia. We asked similar questions to each of them: e.g., How can synaesthesia be defined? Is it inborn? Are synaesthetes special? How does it influence visual artists? Thirty people talked with us, including many of the world's leading synaesthesia researchers, such as Richard E. Cytowic, Lawrence E. Marks, Jamie Ward and Edward M. Hubbard, and famous synaesthete artists such as Anne Patterson, Carol Steen, Timothy B. Layden and Raewyn Turner. Our interview partners from North and South America, Europe, Australia and New Zealand helped create this unique collection and provided many insightful ideas, colourful illustrations and unforgettable descriptions of their experiences.

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