Deutsche Philologie

The Processing of Non-Canonical Sentences in Children with German as a First or Second Language and German Adults Evidence from an Eye-Tracking Study

Inaugural-Dissertation

zur Erlangung des akademischen Grades „Dr. phil."
an der
Westfälischen Wilhelms-Universität, Münster (Westf.)

vorgelegt von

Valentina Cristante

aus S. Vito al Tagliamento (Pordenone, Italien)

2016

Tag der mündlichen Prüfung: (15.02.2017)
Dekan der Philosophischen Fakultät: Prof. Dr. Eric Achermann
Erstgutachter: Jun.-Prof. Dr. Sarah Schimke
Zweitgutachter: Prof. Dr. Christine Dimroth

Acknowledgments

Languages and language learning have always been a very strong interest of mine. Gaining insight into the strategies people make use of when they interpret speech has been a highly compelling and challenging project.

I am very glad that, through a random combination of circumstances, I got to know Jun.-Prof. Dr. Sarah Schimke and Prof. Dr. Christine Dimroth who opened my mind through this research area and accompanied me with passion throughout these years. From both I learned many different things on psycholinguistics, linguistic data processing, scientific thinking, academic research, and life. Their immense knowledge, constructive dialogue and openess towards new approaches have made this time highly enriching and inspiring for me. I am deeply thankful for having had the opportunity to write this work under their supervision at the Philological Faculty of Münster University.

I would like to express my heartfelt thanks to the University of Osnabrück and in particular Prof. Dr. Angela Grimm and Prof. Dr. Renate Musan for having believed in me and for giving me the opportunity to pursue my work, while teaching at the university and presenting and discussing my findings at international conferences.

The *Promotionskolleg Empirische und Angewandte Sprachwissenschaft* of Münster University played a supportive role during my doctoral research and I am very grateful for that. There I was able to expand my knowledge in various linguistic fields, get to know stimulating people, while having a place regularly available for friendly exchange. Thanks to Anja Binanzer, Dr. Elisa Franz, Petra Grycová, Kathrin Thelen, and Dr. Jana Gamper for making the first joint PhD-*Werkstatt* meetings a pleasant and fruitful time.

My warm thanks also to my *Mittelbau* colleagues Julia Hübner, Dr. Nathalie Nikolay, Helena Olfert, Dr. Andrea Peskova, Claudia Polkau, Marina Root, Karsten Schmidt, Dr. Solvejg Schulz, and Steffi Winkler for contributing to the positive and amenable working atmosphere throughout the years at the Osnabrück University.

This work would not have been possible without the collaboration of the Department of Psychology in Osnabrück and the *Nifbe* which kindly put the

eyetrackers at my disposal. I am very thankful for that, and in particular to Dr. rer. nat. Bettina Lamm.

I am grateful to Johanna Hinz and Ina Vosschulte for recording the sound stimuli and all the pupils and heads of schools in Osnabrück and Berlin who participated in this study.

For the time spent outside the university I want to thank in particular Massimo, Andrea, Cristina, Pablo, Kristin, Veronika, Franziska, Sandra, Francesca, Michela, and Simone who helped me keep a healthy distance from my work and gave me a family feeling.

Axel for his closeness during the final spurt.

I can never thank my beloved family, Marino Cristante, Luisa Russolo, and Giulio, enough. Their trust in me and their support have been a continuous source of energy and guidance throughout my life that surmounts any physical distance.

Contents

Abbreviations

ACC = accusative

ADV = adverb

AMB = ambiguous

AUX = auxiliary

DAT = dative

FEM = feminine

G = German

L1 = first language

L2 = second language

LEXV = lexical verb

MASC = masculine

N = neuter

NP = nominal phrase

NOM = nominative

O = object

PL = plural

PPART = past participle

S = subject

SG = singular

SV*fin*O = subject, finite verb, object

T = Turkish

UNAMB = unambiguous

V = verb

Vfin = finite verb

1 Introduction

Language users vary in the degree of knowledge they have of the language(s) in which they communicate on a daily basis. These differences concern both language production – when speaking or writing – and language comprehension – when listening to another speaker or reading a text. This becomes particularly evident if one observes the verbal communication of children, whose language proficiency clearly differs from that of adults. Both the linguistic knowledge available to them and the way they put it to use depend on each language user's experience and cognitive resources.

While exposure to the first language starts at birth, other constellations of language acquisition are possible. In Europe's increasingly multilingual society, language users may start to acquire at different times in their life the languages they end up using on a regular basis. For example, the children of immigrants will be exposed to the language(s) of their immigrant parents at birth, and then a few years later, when they enter an institutional environment, such as kindergarten or primary school, they will start to acquire the majority language of the country in which they live.

Against this background, it is undeniable that both monolingual and multilingual children require many more years of language input coupled with further cognitive development in order to reach adult proficiency. However, exactly how monolingual and multilingual children's knowledge differs from the target linguistic knowledge of adults and how this knowledge develops over time remain open questions.

Knowledge of language is implicit knowledge that is not directly accessible through observation; it is the knowledge that language users rely on when they understand or produce a sentence, and it is activated quickly and unconsciously. Specifically, language users can recognise whether they understand a sentence or not, but they cannot explain how they arrive at this conclusion because the ongoing processes are only subconsciously accessible (Ellis, 2008). For this reason, in order to capture implicit knowledge, we need specific instruments that are able to measure unconscious comprehension processes.

Introduction

In this dissertation we combine two methods that provide a window into participants' linguistic knowledge, on both implicit and explicit levels. With the use of eye-tracking, we monitored the movements of participants' eyes as they shifted their gaze among various visual materials while they were listening to sentences. On the assumption that gaze movements reflect mental processes, this enabled us to track in detail how participants made use of their linguistic knowledge during on-line processing. Then, at the end of each utterance, we measured the participants' overall comprehension off-line by asking them to choose between two pictures, only one of which represented the correct interpretation of the sentence.

We investigated two types of sentences in German, passives and object-first sentences. These structures are often referred to as *Stolpersteine* ('stumbling blocks'), that is, linguistic hurdles with which primary school children have particular difficulty during either first or second language acquisition of German (Ehlich, Bredel, & Reich, 2008). In addition, these structures are assumed to occur frequently in what is called *Bildungssprache*, the more formal and usually written register of German, a familiarity with which is key in the education system.

In this study we explore the on-line and off-line comprehension of these structures and compare the results among three groups of language users, monolingual German children, Turkish-German children and adult German native speakers. The study of sentence processing in a second language is a relatively new area. There are few studies involving child second language learners, and studies of child processing in L2 German are particularly rare, if not altogether nonexistent. Hence, this study can be considered one of the first contributions to the field of child second language processing.

This introductory chapter summarizes some basic insights in the processes underlying sentence processing and briefly discusses the type of linguistic knowledge and the cognitive resources needed for successful sentence comprehension. We present the groups of language users under investigation, describing their similarities and differences, as well as the two structures, passives and object-first sentences. The combined on-line/off-line methodology that was applied is then discussed, with special attention to its advantages. Finally, we formulate the research questions pursued throughout the dissertation and then outline the structure of the work.

Introduction

Sentence processing

When people want to communicate verbally, they produce sequences of content and function words and integrate them into higher levels of organisation, that is, phrases, clauses, sentences and finally discourse. The task of the listener is to comprehend these more or less complex sequences of words, understand how they are organised in order to grasp the meaning in real time and interpret the speaker's intention. To accomplish this task, the listener must segment the sound stream into strings of linguistic units, access individual lexical items and then figure out how the words in the sentence relate to one other. The verbal string presents listeners with a range of bits of information or, in other words, cues that help them to decode the sentence structure. These cues include information at various levels: semantic, syntactic, pragmatic, morphological and phonological. One of the central aims of research on language processing, the ongoing object of intense study, is to reach an understanding of how the different sources of information are integrated in real time.

In the field of language processing, there is general consensus that language comprehension in adults is both rapid and incremental. Speakers produce on average 2.5 words per second, and if language comprehension were not equally fast, listeners would not be able to keep up with such concentrated input. During the process of listening, listeners start out by analysing each word, doing as much interpretative work as possible on the basis of the information they have at their disposal as the sound string unfolds. As soon as new material, that is, new cues in the sentence, become available, the listener immediately updates his or her interpretation. When deriving on-line interpretations, listeners do not only consider the incoming information, they also rely on experience-based expectations for how the sentence will continue. If the listener's expectations are not compatible with the unfolding signal, the initial but now incorrect interpretation is in the best case successfully revised and replaced with the correct one. Failure to update in this fashion can lead the listener to misinterpret the message.

One of the strategies often used by language users is to assume that the first NP of a sentence is the agent of the action, an expectation that we henceforth refer to as the "agent-first strategy". In what follows, we will refer to sentences in which this expectation is correct as "canonical sentences". Those sentences in which this

expectation is violated – when the first NP does not play this thematic role – will be referred to as "non-canonical sentences". In German, both passives and object-first sentences are non-canonical structures, and we will be investigating them here in comparison with their "canonical" counterpart, active subject-first sentences. By doing so, we will explore whether listeners' expectation of a canonical sentence can be identified in their processing patterns and whether and how participants abandon this strategy in order to avoid wrong sentence interpretations, as conflicting cues intervene.

Prerequisites for sentence comprehension

During sentence comprehension, different types of form-function associations or linguistic cues can be used in order to uncover the structure of the sentence and derive the intended interpretation. Language users can only make use of these cues when they possess both the relevant linguistic knowledge and sufficient cognitive resources. Throughout this work, we use the term *cue* as it is defined within the framework of the *Competition Model*. Bates and MacWhinney (1987) postulate that cues are the result of connections between available surface forms (form) and the meaning in the specific context (function), and that the validity of these pairings can be higher or lower depending on their frequency and consistency. Specifically, *validity* is a function of cue *availability*, how frequently the cue occurs in the input, and cue *reliability*, how reliably the cue leads to the correct interpretation. One of the purposes of the model is to quantify the validity of form-function mappings cross-linguistically in order to predict the relative weight that listeners will give to an individual cue during comprehension. Furthermore, as the name of the model itself suggests, the authors argue that several cues in a sentence can either converge, meaning that they work together and point to the same function, or be in competition with each other, pointing to different and therefore competing interpretations of the sentence. Since language is processed incrementally and has a predictive nature, listeners exploit the different cues as they unfold and, on the basis of the cues they already have at their disposal and their relative validity, start to build one or a set of possible interpretations of the sentence. Subsequent cues can then either confirm and hence strengthen the previously constructed interpretations (what the model calls *cue*

coalition) or be in conflict with it (*cue competition*). In cases of cue competition, the listener must decide which cue is more valid. If he or she initially commits to a less valid cue and the second one is more valid, the sentence will be misunderstood, if he or she is not able to revise the initial wrong commitment, that is start relying on the second, more valid cue.

Regarding cognitive resources, we refer in particular to a set of mental processes that is usually summarized as *executive functions*. The development of the executive function system is a crucial achievement in early childood, and it continues to mature during adolescence. Researchers agree that executive functions do not reach their peak until early adulthood (e.g., Davidson, Amso, Anderson, & Diamond, 2006; Luna, Garver, Urban, Lazar, & Sweeney, 2004). Their development is essential for mental and physical health as well as social, cognitive and psychological development.

In the literature, the existence of three essential executive functions is generally agreed upon: *inhibitory control* (including self-control or behavioural inhibition and interference control or selective attention), *working memory* and *cognitive flexibility* (also mental flexibility) (Diamond, 2013; Lehto, Juujärvi, Kooistra, & Pulkkinen, 2003; Miyake et al., 2000). In the present study, we will be concerned in particular with the first two components of the executive function system, inhibitory control and working memory. Though we did not test the two components directly, we believe that they must be considered alongside linguistic knowledge when interpreting the findings of our sentence processing studies.

Inhibitory control and specifically its sub-part, interference control, refers to the ability to selectively focus on a task while ignoring or suppressing incongruent information coming from other stimuli (Parasuraman, 1998). This competence can be measured, for example, with the *Stroop task*[1] (Stroop, 1935; other tests are, e.g., the Flanker task, go/no-go tasks). In sentence processing research, studies with *garden-*

[1] In the Stroop task, participants are asked to name the colour of ink in which some words are displayed. The words either refer to a different colour than the one in which they are displayed (e.g., the word "green" is displayed in yellow) or they refer to the same colour (the word "green" is displayed in green). Results show that participants take longer in the first than the second instance, because of the difficulty in avoiding the interference caused by reading the word.

path sentences[2] have shown that while adults are mostly successful in recovering from syntactic misanalyses, 5-year-old children are unable to do so. This failure to inhibit and revise syntactic misanalyses in order to go on with a new sentence analysis has been related to children´s less well developed inhibitory abilities (Huang, Y., Gerard, J., Hsu, N., Kowalski, A, & Novick, J., 2016; Novick, Hussey, Teubner-Rhodes, Harbison, & Bunting, 2013; Trueswell, Sekerina, Hill, & Logrip, 1999).

Working memory is the ability to hold information in mind and mentally work with it (Baddeley & Hitch, 1994). It includes two types of memory, namely verbal, content-related memory and nonverbal, visual-spatial working memory. In the current work, we use the term working memory to refer to verbal working memory. Within the field of sentence processing, verbal working memory is considered essential for taking several cues into consideration at once (Felser, Marinis, & Clahsen, 2003). A widely used working memory task is the *Reading Span Test* (Daneman & Carpenter, 1980), in which participants are required to combine a processing task and a storage task.[3] Deficit in verbal working memory might prevent listeners from taking into consideration several cues at once during processing as well as holding less frequent sentence interpretations in memory until the end of the sentence in order to understand the meaning.

[2] A *garden-path sentence* is a sentence that leads a listener or reader "down the garden path". When initially confronted with these grammatically correct sentences, the listener/reader pursues a sentence analysis and then at a certain point in the sentence realises that he or she has been misled and must backtrack to correct their initial misanalysis.

[3] In a typical storage task, participants are instructed to read aloud sets of unrelated sentences providing a truth-value judgment for each sentence as they go, and then recall the last word of each of the sentences at the end of each set.

Introduction

Types of language users

In the present dissertation we focused on three types of language users: adult native speakers of German (L1 adults), monolingual German children (L1 children) and Turkish-German children (L2 children). Two age groups of L1 and L2 children were tested: children attending the first year of the German primary school system, aged around 7, and children in the fourth year of primary school, aged around 10.

We opted for these two age groups because previous studies document that at age 10, children are still challenged by non-canonical sentences. In addition, by investigating younger children, we would be able to examine how processing and comprehension develop as the children get older. To control for a possible influence of the age of initial exposure to the L2, we only tested L2 children with an age of initial exposure to German between the ages of 3 and 4. This represents a typical situation for the children of immigrant families, who generally have their first contact with the majority language of the host country with their entrance into kindergarten. In addition, we tested only L2 children whose L1 was Turkish to control for any potential influence of the L1. Turkish is the most widely spoken minority language in Germany (Statistisches Bundesamt Deutschland, 2016).

The three types of language users that we investigated, L1 adults, L1 children and L2 children, present similarities and differences with regard to three factors: age of onset of language acquisition, length of exposure to the target language and age at the time of testing.

The adults and the L1 children do not differ concerning the age of onset of language acquisition, as both started to learn German at birth, but differ with respect to the age at the time of testing and consequently length of exposure. The different age at the time of testing implies a different cognitive maturity, that is, differently developed executive functions. Even though we did not measure executive functions in the groups, we would expect there to be age-related differences in both inhibitory control and working memory. By the same token, the different length of exposure to the language will likely lead to a different proficiency in the language. In comparison to the L1 adults, the L1 children have presumably less knowledge of the linguistic system as well as less processing experience.

Introduction

The L1 and L2 children differ concerning the age of onset of language acquisition and consequently length of exposure, as we compared age-matched children. The L1 children started to acquire the language at birth, whereas the L2 children started to acquire the L2 between the ages of 3 and 4. Their length of exposure to the language is therefore shorter, meaning less knowledge of the linguistic system and possibly different or less entrenched processing routines for the L2 children. In addition, L2 children have knowledge of their L1's grammatical system, which may potentially exert an influence on the L2. The groups do not differ concerning the age at the time of testing and, for this reason, one might expect the children to be similar with regard to their executive functions. However, there are studies comparing monolinguals and multilinguals showing that the latter have advantages in inhibitory processes during nonlinguistic tasks, such as the *Simon task*[4] (Simon & Rudell, 1967). These findings are explained in view of the bilinguals' regular training of inhibition through dual language management. Some authors argue that bilingualism enhances inhibitory control because bilinguals have to constantly solve the competition between two language systems, as lexemes of the two languages are simultaneously activated (Bialystok & Craik, 2010; Bialystok, Craik, Klein, & Viswanathan, 2004; Hilchey & Klein, 2011; Poarch & van Hell, 2012). Other authors claim that better inhibitory processes are related to the ability of bilinguals to select and control which language to use for communicative interaction (Costa, Hernandez, Costa-Faidella, & Sebastian-Galles, 2009). As for the other executive function, working memory, the only findings available to our knowledge relate to comparisons between age-matched L1 and L2 adults. In this case, the findings seem rather to suggest that L2 adults have a disadvantage in comparison to the L1 adults. It seems that working memory resources are strained by processing in the L2, with the L2 adults revealing lower memory scores than natives in verbal working memory tasks (Felser & Roberts, 2007; Williams, 2006). These potential differences between

[4] In the Simon task, children watching a computer monitor are presented with a series of coloured squares one at a time. Each square presents one of two colors (for instance yellow and red) and appears at either the left or right of the screen. The children are instructed to press the right-hand button on a keyboard if they see a yellow square (for example) and the left-hand button if they see a red square, regardless of whether the square has appeared at the right or left side of the screen.

language users at the level of cognitive maturation will be taken into account when discussing the results.

The L2 children investigated in the present study are *early second language learners*. In early second language acquisition the second language is not acquired until the child enters an institutional environment such as kindergarten, whereas the L1 (in this case Turkish) is acquired from birth in the family context. The L2 is not explicitly taught (as in foreign language acquisition classes) but is implicitly learned through the child's immersion in the new language environment. Though corrections and/or explanations by the teaching staff or other children may occur, the effect is not comparable to tutored language instruction. Compared to L1 acquisition, the amount and quality of the language input to L2 children is typically different. For L2 children, input in the L2 is largely confined to the social/institutional setting, whereas L1 children are always immersed in the language, in both the home and the social/institutional setting. As a result of this difference, L2 children are often less proficient than L1 children (Dimroth, 2007; Grießhaber, 2007; Grimm & Schulz, 2014).

The structures under investigation

German is a verb second language (V2), meaning that in declarative main clauses and wh-questions the finite verb is obligatorily placed in second position. The first position may be occupied by any constituent as long as the second position is occupied by the finite verb (Duden, 2009; Eisenberg, 2013; Zifonun, Hoffmann, Strecker, & Ballweg, 1997). When the first position in German transitive sentences is occupied by the subject of the sentence, the resulting order is SV*finO*. When the first position is occupied by any other major constituent, the subject is placed after the finite verb. In transitive sentences with agentive verbs, the syntactic function of the subject typically corresponds to the thematic role of agent and the object to the patient. When the object occurs in preverbal position (henceforth OVS sentences), these frequent object/patient and subject/agent mappings are maintained, but the canonical ordering, agent before patient, is violated. This is also true for passive sentences, where the subject corresponds not to the agent but to the patient, and the object to the agent.

German has a rich case-marking system that distinguishes among four cases: nominative, accusative, dative and genitive. Case is marked on determiners, pronouns, adjectives and question words and in some instances on the noun itself (e.g., dative plural, genitive singular, as well a special class of nouns, the so-called weak masculine nouns). In the present study, we deal exclusively with NPs in which the determiner is the only case-marked element. However, determiners agree not only with case, but also with gender (masculine, feminine and neuter) and number (singular, plural) of the head noun. This already suggests that if one of the three categories is not mastered, there are implications for the final realisation or interpretation of the article. The German case system for definite determiners is illustrated in Table 1.

	Masculine	**Feminine**	**Neuter**
Nominative	Der Mann-Ø	Die Frau-Ø	Das Kind-Ø
Accusative	Den Mann-Ø	Die Frau-Ø	Das Kind-Ø
Dative	Dem Mann-Ø	Der Frau-Ø	Dem Kind-Ø
Genitive	Des Mann-es	Der Frau-Ø	Des Kind-es

Table 1: The German case-marking system in the singular (definite determiners)

As can be gathered from this overview, the system includes a considerable number of syncretisms, making the acquisition of the system a challenging task. Only masculine nouns have a distinct morphology for all four cases; all feminine and neuter NPs show no overt difference between the nominative and accusative case-marking. In this study, we focus on singular masculine and feminine NPs and on the two most frequent grammatical functions, namely the subject, expressed in the nominative case, and the direct object, expressed in the accusative. In addition, the case-marking system is also difficult to acquire because the correct form also depends on the gender of the noun. Gender in turn is difficult to acquire, as there is no clear relationship between the form of the noun and its gender in German.

In German, there are two structures in which the ordering of the thematic roles deviates from the canonical ordering, agent-before-patient. This is the case of passive sentences and OVS sentences.

Introduction

Passive sentences maintain the syntactic dominant word order, SV*fin*O. However, in contrast to actives, the first NP, the subject in passives, encodes the patient and the object encodes the agent, as illustrated in (1) below.

(1) Der Opa wurde von der Oma gekitzelt
The-MASCNOM grandpa was-AUX by the-FEMDAT grandma tickled-PPART
'The grandpa was tickled by the grandma'

Syntactic functions: Subject + Aux + Object + lexV
Semantic roles: Patient + Agent + Action

Passive sentences are produced in order to highlight the patient of an action. The agent is defocused (Eisenberg, 2013) by means of appearing in a syntactically non-prominent position, the by-phrase. Note also that this phrase is not obligatory, such that the agent can and often is omitted from passive sentences completely. The discourse contexts licensing the use of passive sentences are more varied when compared to those licensing the use of OVS-sentences. For instance, passive sentences are used also in cases where the patient is new in the discourse.

In the present study, we will focus on the comprehension of one type of passive, namely the eventive passive, which describes an event between an agent and a patient. Because the auxiliary verb involved in this structure is *werden*, this passive is also referred to as the *werden*-passive and is the most frequent passive construction in both written (Brinker, 1971) and spoken German (Eisenberg, 2013). Moreover, we will work with sentences in which the auxiliary *werden* is in the past tense, since the present tense form can also be used as part of the future tense construction when it is followed by an infinitive, thus making the sentence temporarily ambiguous between a future and a passive reading (Abbot-Smith & Behrens, 2006; Knoeferle, Crocker, Scheepers, & Pickering, 2005). This is not the case in sentences using the past tense *wurden,* which cannot indicate a future action. Nevertheless, *wurden* is not immune to ambiguous readings since it can also be used as a copula verb, as in *Der Opa wurde taub*, 'The grandpa became deaf'.

The morphosyntactic cues signalling an eventive passive are the auxiliary *werden,* the *von*-phrase (*by*-phrase) introducing the dative-marked second NP and the past participle confirming the finite verb as auxiliary and not as copula.

Assuming that participants expect the first NP to be the agent, thus interpreting the sentence according to what we call an "agent-first strategy", the hurdle for the listener with passives is to revise this expectation. More precisely, when fully exploiting the morphosyntactic cues pointing to the passive, listeners get the information that the first NP is the patient and not the agent and can thus override the initial expectation of a canonical sentence that turns out to be incorrect.

The second structure under investigation is OVS sentences, which maintain the canonical subject/agent and object/patient mappings but show a non-canonical ordering of the thematic roles, since the first NP is the patient and not the agent.

Similarly to passive sentences, the patient is highlighted in OVS-sentences. Differently from passive sentences, the agent is not necessarily defocused, and it cannot be omitted. OVS-sentences are used in specific information structural contexts. In particular, the object of an OVS-sentence is typically given in the prior context.

In this study, we investigate two types of OVS sentences, which we name "unambiguous OVS sentences" and "temporarily ambiguous OVS sentences". In both types, the first NP is marked as the object by accusative case-marking. However, due to the several syncretisms that occur in the German case-marking system, as noted above, the object is not always unambiguously identifiable as such. Only masculine NPs are clearly distinguishable in the nominative and accusative case, whereas feminine and neuter are not.

In "totally unambiguous OVS sentences" (2), the first masculine NP is the accusative marked object. This is the first cue for the listener signalling the sentence as an OVS sentence. The following disambiguating cues are the auxiliary, the personal pronoun and the past participle. The auxiliary in the first person singular signals that the first NP is not the subject, whereas the personal pronoun is clearly nominative and agrees with the auxiliary in person and number. The past participle distinguishes the finite verb as auxiliary but does not provide any disambiguting cue for the ordering of thematic roles.

(2) Den Opa habe ich gekitzelt
The-MASCACC grandpa has-AUX me-PRON. tickled-PPART
'I tickled the grandpa'

Syntactic functions: Object-masc/unamb + Aux + Pron. + lexV
Semantic roles: Patient + Agent + Action

Language users do not always have all these cues at their disposal in order to recognize OVS sentences. For example, in those OVS sentences that we refer to as "unambiguous OVS sentences*"* (3), listeners have only one cue, namely the first NP. The auxiliary and second NP are not informative. The auxiliary agrees with both the first and the second NP, and, being feminine, the second NP is ambiguous and thus might potentially also be interpreted as the object/patient. As in sentence (2), the past participle confirms the finite verb as auxiliary and does not offer any disambiguating cue for the thematic role assignment.

(3) Den Opa hat die Oma gekitzelt
The-MASCACC grandpa has-AUX the-FEMNOM/ACC grandma tickled-PPART
'The grandma has tickled the grandpa'

Syntactic functions: Object-masc/unamb + Aux + Subject-fem/amb + lexV
Semantic roles: Patient + Agent + Action

The other OVS structure investigated here is "temporarily ambiguous OVS sentences". In contrast to the previous type of OVS sentence, the first NP is not the first disambiguating cue because, being in this case feminine, it is ambiguous between the accusative and nominative case. Nor does the auxiliary offer any disambiguating cue either, as it agrees with both the first and the second NP. Thus the first cue that comprehenders have at their disposal to disambiguate the sentence is the masculine second NP, whose nominative case-marking clarifies its syntactic role. As in the previous sentences, the past participle signals the finite verb as auxiliary. Hence, the listener must wait for the second NP to realise that the structure is non-canonical.

(4) Die Oma hat der Opa gekitzelt
The-FEMNOM/ACC grandma has-AUX the-MASCACC grandpa tickled-PPART
'The grandpa has tickled the grandma'

Syntactic functions: Object-fem/amb + Aux + Subject-masc/unamb + lexV
Semantic roles: Patient + Agent + Action

It should be noted that because of the syncretisms in the German case-marking system, there are also OVS sentences whose ambiguity cannot be resolved by reference to case-marking. However, in the present study, we will limit ourselves to measuring listener reactions to OVS sentences whose ambiguity can be resolved by case-marking, since fully ambiguous sentences would not give us useful information.

Similar to passives, if we assume that participants interpret the first NP as the agent, we would expect difficulties with OVS sentences, as listeners must revise the initial wrong canonical expectation. However, unlike passives, in OVS sentences there is only one disambiguating cue at the listener's disposal, namely the case-marking on the first NP (in unambiguous sentences) or on the second (in temporarily ambiguous sentences). In passives, listeners have the auxiliary as well as the second NP as disambiguating cues.

Furthermore, the disambiguation is caused by case-marking on the determiner of the noun, and case morphology is counted among the major obstacles in L1 and L2 acquisition.

Finally, it is important to note that the abovementioned cues are not the only cues characterising passive and OVS sentences. In natural language, there are certainly other cues that occur when these sentences are encountered, such as intonation, context and pragmatic plausibility (information structure). Nevertheless, in the present study we focus exclusively on morphosyntactic cues, as it is often claimed that they are not easily exploited by young learners. The purpose of this study is to determine whether morphosyntactic cues are effective for children, and this research objective can only be pursued by neutralising all other cues.

On-line and off-line measures

As stated above, in this dissertation two methods are combined in order to gain insight into participants' linguistic knowledge *in toto:* an *on-line* method, which captures participants' implicit linguistic knowledge as it is applied while listening to the sentence, and an *off-line* method, which explores participants' explicit knowledge after listening to the sentence.

The reason for combining these two measures can be extrapolated from the following example. Imagine being asked to answer some comprehension questions after having read this text. Even if you were to answer the questions correctly, it would by no means be apparent how you processed the individual sentences in the text and whether parts of the text were actually more challenging than others. The only information available would be that you had successfully understood the meaning of the text. In the same vein, at the level of oral sentence comprehension, while we know that children and sometimes even adults experience considerable difficulty in comprehending non-canonical sentences, we have no insight into the step-by-step path their mind follows as they listen to the sentences, leading ultimately to the right interpretation or an erroneous one. By combining the two methods, we have information on how participants make use of their linguistic knowledge during on-line processing as well as how they integrate this knowledge in order to reach a conclusion at the end of the sentence. Most of the research carried out in this area to date has done one or the other, but not both, with the majority of studies limiting themselves to measuring participants' off-line interpretations, and the few existing on-line studies focusing on languages other than German (e.g., Huang, Zheng, Meng, & Snedeker, 2013; Snedeker & Trueswell, 2004; Stromswold, under review).

The measurement of participants' off-line and on-line performance is advantageous to obtain a comprehensive picture of children's comprehesion, as previous studies with L1 and L2 children demonstrate that the results of the two methods do not always converge. Specifically, previous studies document that children sometimes reveal linguistic knowledge of the cues during on-line processing, that is, they make use of them and weight them appropriately, but fail to display this knowledge and/or show it less in the explicit off-line task. This is because children have difficulty integrating all the cues they have reacted to as well as keeping in mind

less frequent sentence analyses to the end of the sentence (Adani & Fritzsche, 2015; Huang et al., 2013; Marinis, 2007). On the other hand, other studies within the field of L2 adult processing document that on-line processing in these groups might be very different from that seen in L1 adults, meaning that adults may use different processing strategies or experience relatively greater difficulty during processing even if they ultimatively arrive at a native-like interpretation of the respective structures (Clahsen & Felser, 2006; Hopp, 2010; Jiang, 2004)

By collecting both on-line and off-line data, we might be able to show, on the one hand, that participants reveal reactions to cues and thus linguistic knowledge that we would have ignored by considering the off-line scores alone. On the other hand, we might also be able to show that participants may arrive at correct off-line interpretations by means of very different processing strategies, or at different speeds.

In the present study, in order to test participants' on-line comprehension, we monitored their eye movements using the *Visual World Paradigm* (Tanenhaus, Spivey-Knowlton, Eberhard, & Sedivy, 1995). Thus, participants were presented with an auditory stimulus and simultaneously confronted with a set of visual materials on a computer screen. As they listened to the stimulus, their eye movements were continuously tracked by cameras to see which visual element or elements they gazed at as the sentence unfolded. The basic assumption of this paradigm is that visual attention and grammatical processing are intimately linked, in other words, "the mind is going where the eye is going" (Trueswell & Gleitman, 2007: 15). Thus, by measuring visual attention during the unfolding of words or phrases, "researchers can get an insight into the real-time processes by which the listeners organize utterances structurally and semantically, and how they map these representations onto the events and objects that they denote" (p. 15). As stated above, language processing takes place in an incremental fashion; a listener forms almost immediately a working hypothesis of what the sentence is ultimately going to mean and then updates and revises that hypothesis as the sentence unfolds and new information appears. These revisions take place on a scale of milliseconds, as do the changes in gaze direction. But a video camera can capture these split-second eye movements and the video recording can then be matched frame by frame to the audio signal for analysis. The final product is a detailed picture of the participants' processing of specific parts of

the auditory stimulus. In the present study, attention was paid to participants' eye movements as they heard the cues marking the canonical and non-canonical structures. The visual stimuli consisted of pairs of pictures depicting the action described in the sentence, once with congruent and once with incongruent assignment of thematic roles. The analysis of the eye gaze behaviour during critical time intervals allowed us to determine whether participants' eye movements were directed more at the "target" picture, i.e., the picture accurately illustrating the meaning of the sentence or at the "competitor" picture, i.e., the picture which depicted the roles in a reversed fashion.

The analysis of the eye gaze movements provides us with specific information about which strategies participants employ. First, we can explore whether participants make use of any strategy at all, with unsystematic (i.e. chance-level) changes in eye movement a clear indication of the absence of a strategy. Alternatively, we might find systematic patterns of eye movement indicating that participants are attempting to make use of an "agent-first strategy" during non-canonical sentences, resulting in fixations to the target picture below chance level and fixations to the competitor picture above chance level. In this case, the strategy will yield an erroneous interpretation because in non-canonical sentences the first NP is the patient, not the agent. Second, through participants' eye gaze movements we can examine the degree to which participants rely on different cues, that is, whether they assign different weights to different cues. For instance, if we find that participants correctly exploit the accusative case-marking on the first NP (i.e., when fixations to the correct picture are above chance level), the exact percentage of target fixations will tell us how pronounced their reliance on this cue is. Third, by investigating eye gaze movements in time intervals of 20 ms, we can detect when participants start to react to the cues, that is, at precisely which point in the sentence the eye gaze movements directed at the target picture start to increase past chance level.

Research questions

Over the course of four studies, we tested monolingual German-speaking adults (the L1 adults), monolingual German-speaking children (the L1 children) and Turkish-German children who spoke Turkish at home but had entered a German-language

educational context at age 3 or 4 (the L2 children). The following research questions were asked:

Off-line interpretations:

(1) Do participants interpret non-canonical sentences correctly in the off-line task?

On-line interpretations:

(2) How do participants process non-canonical sentences on-line?

(2a) Do they react according to an "agent-first strategy"?

(2b) Do they react to the cues marking non-canonical sentences?

(2c) Are there differences with respect to (2a) and (2b) in terms of timing and reaction intensity?

Relation between on-line and off-line preferences

(3) How close is the relation between on-line processing and final judgements?

(3a) When a group exhibits high accuracy in off-line judgements, will they also do so in on-line processing?

(3b) When a group misinterprets non-canonical sentences, will they nevertheless react to the relevant cues on-line? If so, to what degree and how quickly?

For each research question we asked whether the groups under comparison differed in this respect.

If the answer to question (3a) is negative or differs across groups, this may mean that despite the fact that participants were successful in comprehending the non-canonical structures, they experience differences in the path towards this high performance, that is, they may take longer to revise their interpretation or they may exploit only a subset of cues. Note that these differences would remain undetected if we were to consider the high off-line scores alone. By the same token, in using our on-line data to answer question (3b) we should be able to provide evidence that the children possess the necessary linguistic knowledge even if it does not ultimately lead them to high off-line scores, because their cognitive resources for overall interpretation are strained.

Introduction

Research perspectives

The present work approaches the topic of off-line and on-line sentence comprehension from two perspectives. First, from a developmental perspective, we compare monolingual participants of different ages – 7-year-olds, 10-year-olds and adults – in order to investigate similarities and differences in language comprehension as a child grows older with the adults functioning as a control group. Second, from a multilingual perspective, we compare age-matched L1 and L2 children and look for similarities and differences in the way they process the same German structures.

The two perspectives are relevant to both first and second language processing in children. Concerning first language processing, the present findings can contribute further evidence to previous findings showing that children in the course of development learn to acquire the form-function mappings or cues of their language and also learn to weight them in an adult-like fashion. By showing how children and adults exploit cues in real time, most importantly, we can help build a precise developmental picture of how listeners learn to rely on the "agent-first strategy" and morphosyntax to decode sentences. In particular, we can explore whether on-line reliance on cues as well as their final integration changes as children get older. The present findings are novel because no study so far has combined on-line and off-line data across different age groups.

As for the multilingual perspective, the comparison of monolingual children (L1 children) and early second language learners (L2 children) is an area of research currently undergoing considerable growth (see, among others, Dimroth & Haberzettl, 2008; Grimm & Schulz, 2016; Klages & Gerwien, 2015; Meisel, 2009; Schimke, 2015). One of the purposes of such studies is to find out whether and how bilinguals who are first exposed to L2 around 3-4 years differ from their monolingual peers in their final interpretation of complex sentences and/or their on-line sentence processing. In the area of second language processing, most of the available studies include adults, that is, late second language learners, or simultaneously bilingual children (Bialystok & Craik, 2010; Clahsen & Felser, 2006; Hopp, 2006; Schimke, 2009). However, the early second language learner scenario is very common in Europe's increasingly multilingual society. Many European children nowadays are

exposed in the first years of life to the language of their immigrant parents, yet as soon as they enter an institutional environment they are immersed in the language of the host country in which they live and are expected to rapidly become as proficient as their monolingual peers.

Structure of the dissertation

The dissertation is composed of four studies, which may in fact be read separately, as each study is self-contained insofar as it includes its own theoretical background, methodology, results and discussion. The final section of the work brings all this information together in an overall summary and discussion of the significance of the four studies taken as a whole.

(1) The first study investigates how L1 7-year-olds, 10-year-olds and adults react on-line and off-line to passive sentences, thus investigating comprehension from a developmental perspective (experiment 1).
(2) The second study investigates how L1 and L2 7-year-olds and 10-year-olds react on-line and off-line to passive sentences, thus investigating comprehension from a multilingual perspective (experiments 2.1, 2.2).
(3) The third study investigates how L1 7-year-olds and adults react on-line and off-line to unambiguous and temporarily ambiguous OVS sentences, thus investigating comprehension from a developmental perspective (experiments 3.1, 3.2).
(4) The fourth study investigates how L1 and L2 7-year-olds react on-line and off-line to unambiguous and temporarily ambiguous OVS sentences, thus investigating comprehension from a multilingual perspective (experiments 4.1, 4.2).

2 The processing of German passive sentences in child and adult native speakers

2.1 Introduction

Languages provide their speakers with cues which allow them to determine who is the doer of the action expressed by a transitive verb. Language learners must recognize and exploit these cues in order to correctly interpret sentences and convey meaning. In this context, an important question for language scientists to explore is what strategies listeners make use of to assign thematic roles. In canonical transitive sentences in English, German and many other languages, the subject linearly precedes the object. If the sentence contains an agentive verb, such that the subject referent receives the thematic role of an agent, and the object referent of a patient, this means that the agent is mentioned before the patient (1).

Most languages also present an inversed ordering of the thematic roles, in which the agent occurs after the patient. In these sentences the thematic roles might be expressed under different syntactic functions and the focus is shifted to the acted-upon entity (2). The patient is expressed by the subject of the sentence, whereas the agent, if expressed, by the *by*-phrase (Eisenberg, 2013).

(1) Active: Der Opa hat die Oma geküsst
The grandpa-NOM has kissed the grandma-ACC
Subject/Agent - Aux - Object/Patient - lexV/Action

(2) Passive: Der Opa wurde von der Oma geküsst
The grandpa-NOM was kissed by the grandma-DAT
Subject/Patient - Aux - Object/Agent – lexV/Action

Studies on the comprehension of English and German passives have shown that children initially go through a phase in which they misinterpret passives because they interpret them as if they were actives (for German: Aschermann, Gülzow, & Wendt, 2004; Dittmar, Abbot-Smith, Lieven, & Tomasello, 2014; Grimm, 1975; Mills, 1977,

1977; for English: among others, Maratsos, 1974, Stromswold, under review; Turner & Rommetveit, 1967). When they get older, their comprehension is facilitated when semantic and pragmatic cues are available in addition to the morphosyntactic cues. When such cues are neutralized, as is the case of reversible passive sentences, acquisition takes more time (for German: Aschermann, Gülzow, & Wendt, 2004; Grimm, 1975; for English: Turner & Rommetveit, 1967).

The passive structure is a source of mistakes even for mature speakers, who occasionally misinterpret passive sentences, especially when morphosyntactic cues are in conflict with semantic cues, such as in the case of implausible passive sentences like *The mum was fed by the baby* (Dąbrowska & Street, 2006; Ferreira, 2003), and take longer to process them (Ferreira, 2003). The origin of these misinterpretations of and higher processing costs for passives even among mature speakers seems to be the same as for younger learners. Children misunderstand passives because they expect the first NP to be the agent of the action, thus making use of the strategy that we have labelled "agent-first strategy". Adult misinterpretations are also considered the result of simple processing heuristics, such as the "agent-first strategy" instead of syntactic algorithms (Ferreira, 2003).

In sum, the abovementioned studies have provided us with a picture of adults´ and children´s ultimate comprehension of passive sentences, leaving however the question open as to whether the same scenario, that is the same cues´ exploitation over development is observable if we have a look at their on-line comprehension and specifically at how they make use of the "agent-first strategy" and morphosyntax in real time, while listening to the sentences. More precisely, this study is concerned with investigating first, whether and when German adults as well as 7- and 10-year-old children make on-line use of the "agent-first strategy" and the morphosyntax, when they are in coalition, during actives (the active morphosyntax supports the "agent-first strategy") and second, when they are in conflict, during passives. Third, we also want to find out how the patterns change over development. By doing this, we aim at getting a more detailed insight into the path that children go through in order to finally correctly understand passive sentences, by examining how they exploit and weight the cues at their disposal in order to correctly understand the sentences. To test this, we explored how two age groups of German children, 7-year-

olds and 10-year-olds and adults process active and passive sentences using the *Visual Word Paradigm* (Tanenhaus et al., 1995) in which participants were presented simultaneously with two pictures and auditory stimuli.

In the remainder of the introduction, we will briefly review off-line studies on the comprehension of passives by children and adults and will then present in more detail studies dealing with the on-line processing of this construction.

2.2 The acquisition and the processing of passive

2.2.1 Acquisition in monolingual children

Off-line studies on the comprehension of English and German passives using act-out and sentence-picture matching tasks have shown that children at the earliest stages of linguistic development interpret the sentences predominantly according to the "agent-first strategy" (for German: Aschermann et al., 2004; Dittmar et al., 2014; Grimm, 1975; Mills, 1977; for English: Maratsos, 1974; Stromswold, under review; Turner & Rommetveit, 1967). Children make strong use of this expectation even if this strategy in German is not the most *valid* one (Dittmar, Abbot-Smith, Lieven, & Tomasello, 2008).[5] In the framework of the *Competition Model*, *cue validity* is a function of *cue availability*, how frequent the cue is in the input, and *cue reliability*, how reliable the cue is in leading to the correct interpretation (Bates & MacWhinney, 1989). Note that, unlike English, which relies predominantly on the "agent-first strategy" to encode grammatical functions, German has a wide variety of surface word order patterns and relies on case-marking in addition to the "agent-first strategy" (Dryer, 1995). Nonetheless, research shows that in interpreting input Germans rely on the prototypical, most frequent ordering agent-before-patient and then start to make use of more reliable language-specific cues (Dittmar et al., 2008; Dittmar et al., 2014). This phenomenon has also been found in child studies of other languages (for Turkish: Candan et al., 2012; for Spanish: Pierce, 2009; Reyes & Hernández, 2006; for Mandarin: Chan, Lieven, & Tomasello, 2009; for Cantonese:

[5] In the framework of the *Competition Model*, what we refer to as the "agent-first strategy" is a cue that they refer to as "word order". In our conceptualisation, however, the "agent-first strategy" is not a cue but rather an interpretation preference, since one can have this strategy in mind even before the sentence starts in the absence of any cues.

Miao, Chen, & Yin, 1984; Slobin & Bever, 1982; for English: Bever, 1970; Maratsos, 1974; Turner & Rommetveit, 1967).

In this context, some authors assign the "agent-first strategy" a more universal character. Bever describes "any Noun-Verb-Noun sequence within a potential internal unit in the surface structure corresponds to agent-action-object", thus underlying the occurrence of the agent before the patient (1970: 298). In a similar vein, Friedmann and Novogrodsky (2004) formulated the *Canonicity Hypothesis*, according to which children follow a linear pattern when assigning thematic roles to arguments, so that the first NP is interpreted as the subject of the sentence and the agent of the action and the second as the object and patient. Furthermore, researchers working in cognitive linguistics argue that the realisation of the agent before the patient corresponds to the canonical event structure representation as the agent is the entity that causes the action and in turn affects the patient that comes second (Givon, 1995).

This predicted reliance on the "agent-first strategy" at the earliest stages is confirmed by several studies on passives in which German-speaking children are shown to prefer to describe actions from an agent perspective, in the active voice, and to often misinterpret passive sentences (Haberzettl, 1998).

With regard to production, until the age of 3, German-speaking children have been shown to produce almost no passives (Mills, 1985), even if one study involving novel verbs reported that 34-month-old children already know the passive morphosyntax (Wittek & Tomasello, 2005). Until the age of 6, solely one-argument/agentless passives are produced (Fritzenschaft, 1994; Grimm, 1975; Mills, 1985) and in primary school age, passives are still sporadic (below 1%, Rickheit, 1975). In a sentence elicitation task, Haberzettl (1998) showed 6- to 7-year-old children pictures and asked them passive-biasing questions intended to elicit information about the patient of the action, such as *Was passiert mit dem Schneider?* 'What happened with the tailor?', thus encouraging the children to begin their answer with the corresponding NP. The study found that only 20-33% of answers included a passive structure. In most cases, children preferred to change the topic and start the answer with the agent of the action.

With regard to comprehension, evidence from an act-out study by Grimm (1975) showed that children (mean age 3;6) also make use of the "agent-first strategy" with irreversible passive sentences.[6] As they get older, children start to rely more on other cues, such as semantic and pragmatic ones, obtaining thus higher scores with irreversible than reversible passives, as the latter do not provide any semantic or pragmatic cues (i.e., a prototypical agent) for disambiguation (Grimm, 1975; Mills, 1977 for semantic cues; Schaner-Wolles, 1989, for pragmatic cues). According to these studies, only after the age of 5 does children's overreliance on the "agent-first strategy" begin to diminish as they start to rely more on the passive morphosyntax, thus becoming more successful in the comprehension of reversible passives (Aschermann et al., 2004: 79%; Becker, 2006: 73%; Dittmar et al., 2014: 82%; Grimm, 1975: 88% of correct interpretations of passive sentences, respectively).

Importantly, what these studies also show us is that while children initially comprehend actives at ceiling, reversible passives are not 100% misunderstood from the beginning. This indicates that children are sensitive to the passive morphosyntax from the earliest age groups investigated so far. If they were not sensitive to it and relied exclusively on the "agent-first strategy", we would expect 100% incorrect interpretations of passives.

2.2.2 On-line processing studies with monolingual children

There are two eye-tracking studies that have investigated the comprehension of reversible passives by children, providing an insight into how English and Chinese children coordinate and weight the "agent-first strategy" and morphosyntax during processing.

Stromswold (under review) monitored the eye gaze of two child groups (5;2 and 6;2) and adults (Stromswold, Eisenband, Norland, & Ratzan, 2002) while listening to reversible active and passive sentences in English (active: *The boy was*

[6] In irreversible passives, semantic information may be provided by the animate nature of the two NPs, the agent or the patient, such that only one of the two can logically be agent of the described event or by the plausibility of the event, such that only one of the two NPs can be the plausible agent of the described event (in the sentence e.g. *Der Boden wird von Hans geküsst* 'The floor is kissed by Hans', Hans cannot be kissed by the floor).

pushing the girl and passive: *The boy was pushed by the girl*) and inspecting two pictures. The pairs of pictures differed from one another in whether the first NP was the agent of the action or the patient, such that one picture was congruent with the sentence being heard and one was not. She found that both child groups processed actives on-line, showing a pronounced reaction to the active cues, whereas during passives, children did not show a strong preference for one or the other of the two pictures. Furthermore, the study revealed differences in processing between the 5-year-olds and the 6-year-olds. The former showed a highly pronounced "agent-first-strategy" immediately after the processing of the first NP, suggesting that they approached the sentences by assuming that the first NP was the agent and mostly failed to revise their initial incorrect interpretation during the processing of the passive sentences. On the other hand, the 6-year-olds did not show any preference during the first NP but did reveal a very weak "agent-first strategy" after the onset of the auxiliary *was* (of actives and passives) and until the offset of the *by*-phrase (for passives, while during actives from the auxiliary until the final choice). After the end of the sentence, during the time children needed to select the correct picture, gazes at the congruent picture began to increase sharply. The same initial absence of an "agent-first-strategy" was observed in the adults. The authors interpreted this initial lack of preference as a behaviour aimed at avoiding the high computational costs associated with a later reassignment of thematic roles whenever cues conflicted with the initial strategy.

Similarly to the 5-year-olds investigated by Stromswold, the same origin of misinterpretations due to a failure in reanalysis has been observed in an eye-tracking study on the comprehension of the Chinese passive. Huang et al. (2013) recorded the eye movements of 5-year-olds and adults during active and passive sentences in which the first constituent, respectively the agent and the patient, was explicitly expressed by a NP (*Seal BA/BEI it quickly eat*, 'The seal is quickly eating it/The seal is quickly eaten by it') or by a pronoun (*It BA/BEI seal quickly eat*, 'It is quickly eating the seal/ It is quickly eaten by the seal'), both followed by the active and passive morphology. During the sentences, participants were presented with three objects, the referent expressed in the sentence, another object which could perform an action with the expressed referent and a third object with which the expressed

referent could not perform the action The aim of the study was to examine whether Chinese adults and children made use of the morphosyntactic markers to make on-line predictions of thematic roles. Moreover, by manipulating the first constituent, the authors observed whether the presence of an explicit first NP instead of a pronoun had any influence on the processing. The findings revealed a stronger sensitivity to the passive morphosyntactic cue, BEI, when it followed the pronoun than when it followed the noun. When children heard the marker BEI after the pronoun, they were less likely to immediately assign any role because of the referential ambiguity of the pronoun. This suggests that the "agent-first strategy" is more pronounced when the first NP refers to a clearly identifiable referent to which the agent role can be assigned. These findings are explained by the *Incremental Processing Hypothesis* (Trueswell & Tanenhaus, 1994; Trueswell & Gleitman, 2007), according to which the point in time at which strategies and/or cues occur in the utterance affects comprehension. "Cues that are available early in an utterance may lead a child to commit to an interpretation that is inconsistent with the following cues" (Huang et al., 2013: 3) and more difficult to revise thereafter.

This general difficulty faced by children in abandoning their initial sentence interpretation and revising the sentence as subsequent contradictory cues unfold has been shown by several studies (Choi & Trueswell, 2010; Trueswell et al., 1999; Weighall, 2007). These studies have examined children's comprehension of so-called *garden-path sentences* and agree that until the age of 5, children have difficulties in recovering from initial misinterpretations due to a deficit in inhibitory control. Specifically, inhibitory control is the capacity of inhibiting irrelevant cues, and studies on language processing have shown that inhibitory control seems to correlate with the ability of syntactic revision of erroneous interpretations. It has been argued that while adults are mostly successful in recovering from syntactic misanalyses, the less developed inhibitory abilities in children might be the causal factor for their inability to revise syntactic misanalysis (Huang et al., 2016; Novick et al., 2013).

2.2.3 Off-line comprehension studies with adults

Off-line studies with mature listeners have shown that they do not always comprehend the passive construction flawlessly. Ferreira (2003) asked English adults to identify the agent in plausible and implausible passive sentences and found mistakes that were due to misassignments of thematic roles based on the "agent-first strategy" (plausible, 90% correct and implausible, 80% correct). Dąbrowska and Street (2006) provided evidence that speakers with lower levels of education have more difficulties than speakers with higher levels in the comprehension of these sentences (respectively, plausible passives: 100% vs. 89% and implausible passives: 96% vs. 36%).

The authors of these studies argue that listeners often make use of their syntactic knowledge in a shallow manner. The result of their comprehension would then be what Ferreira calls a "good enough" representation instead of a detailed syntactic analysis. However, due to the fact that these two studies provided off-line data only, the question remains open as to how different strategies are coordinated and weighted during processing.

2.2.4 On-line processing studies with adults

Two studies to our knowledge have investigated the processing of non-canonical German sentences by monitoring the eye movements of adults during comprehension using the *Visual Word Paradigm* (Kamide, Scheepers, & Altmann, 2003; Knoeferle et al., 2005).

Knoeferle et al. (2005) presented German adults with initially structurally ambiguous active and passive sentences. The structural ambiguity consisted of an initial feminine NP (e.g. *Die Prinzessin* 'the princess'*)*, which in German corresponds to either the nominative or accusative case-markings and can encode both agent and patient, and the auxiliary *werden* in the present tense, which is ambiguous between the auxiliary of the future tense or a copula verb (active voice) and the passive auxiliary (passive voice). The first disambiguating cues to active and passive were biasing adverbs (e.g. *sogleich*, 'soon' for the active voice and *soeben* 'currently' for the passive voice) followed by the *de facto* unambiguous active and passive cues on

the second NP. For active sentences, a masculine accusative-marked NP followed by an infinitive verb (active: *Die Prinzessin wird sogleich den Pirat waschen*, 'The princess (agent) will soon the pirate (patient) wash'). For passive sentences, a *von*-phrase, the preposition *von* followed by a dative case-marked noun and a past participle (passive: *Die Prinzessin wird soeben von dem Fechter gemalt* 'The princess (patient) is currently having her portrait painted by the swordsman (agent)').

Eye movements were monitored while participants were listening to the sentences and inspecting a scene in which the ambiguous first NP (the princess) was both engaging in the action (as an agent – washing the pirate) and at the same time undergoing the action (as a patient – being depicted by the swordsman). The goal of this experiment was to observe whether participants made on-line use of the disambiguating cues by showing their preference in the visual context for one of the two role-relations by means of predictive gaze fixations. If participants make use of the "agent-first strategy", thus considering the first NP, *die Prinzessin* as the agent, it is expected that participants will subsequently inspect the patient, the referent in the visual context which undergoes the action started by the princess (the pirate). Knoeferle et al. (2005) found that participants made use of an "agent-first strategy", with the onset of the ambiguous auxiliary *werden* by showing more predictive inspections of the patient (the pirate) during both active and passive sentences starting with the princess. The pattern was observed to change after the offset of the biasing adverb, slightly before the onset of the disambiguating active and passive second NP, with gaze directed more often at the patient for actives (the pirate) and more often at the agent for passives (the swordsman).

The same tendency to start processing transitive sentences as if they were actives was also shown by Kamide et al. (2003). They compared SVO to OVS sentences in which the first NP was unambiguously marked as nominative (*Der Hase frisst gleich den Kohl* 'the hare (S) eats soon the cabbage (O)') or accusative (*Den Hasen frisst gleich der Fuchs* 'the hare (O) eats soon the fox (S)'). The semantics of the verbs was also expected to constrain interpretation, as participants were shown four objects in the visual screen (a hare, a cabbage, a fox and a distractor) presenting different plausible subject-object relationships in the context of the verb *eating*. The results showed a preference to interpret the first NP as the agent despite the

accusative marking of the first NP in the OVS construction (*Den Hasen*). However, anticipatory glances at the subject for OVS (the fox, instead of at the potential object of the hare, the cabbage), suggesting a revision of the initial wrong "agent-first strategy" were detected only after the onset of the adverb (*gleich*), that is after the onset of the second disambiguating cue, namely the verb and not immediately after the accusative-marked first NP.

The main findings of the two on-line studies above provide evidence that German adults start to initially process sentences as if they were actives after the onset of the first NP. During passives, they are able to reverse this pattern as soon as the passive auxiliary occurrs. More difficulties are detected for adults when the competing cue is directly marked on the first NP (*den*). In this case, adults are shown to revise the "agent-first strategy" later with the help of further disambiguatng cues, such as semantic cues.

2.3 Study 1, Experiment 1

2.3.1 Overview and research questions

This study focuses on the German *werden*-passive, which is the most frequent passive construction in both written (Brinker, 1971) and spoken German (Eisenberg, 2013). From a formal perspective, the passive structure we investigate presents SV*fin*O word order with the subject as patient and the object as agent. The passive morphosyntax, namely the auxiliary *werden* and the *von*-phrase '*by*-phrase'[7] including a dative-marked second NP, assigns the role of agent to the second NP and the role of patient to the subject.

For the current study, we opted for the auxiliary *werden* in the past tense. This was done because the present tense form can also be used as part of the future tense construction when it is followed by an infinitive. A sentence can thus be temporarily ambiguous between a future and a passive reading (Abbot-Smith & Behrens, 2006; Knoeferle et al., 2005). This is not the case of a sentence using the past tense of *werden-wurden* which cannot indicate a future action, but only the past tense of the

[7] In the passive structure the auxiliary *werden* is obligatory, while the *von*-phrase is not (Eisenberg, 2013; Zifonun et al. 1997).

copula *werden*. We compared thus past tense passive sentences to active sentences in the present perfect, which in German, also refers to the past. Both constructions are thus analytic constructions with the auxiliary in second position (*wurde* indicating the passive or *hat* indicating the present perfect) and the non-finite past participle appearing sentence-finally.

The research questions we adress in the current study are as follows:

(1) Do the three groups, 7-year-olds, 10 year-olds and adults interpret passive sentences correctly in the off-line task?

(2) How do the three groups start to process the sentences when they are still ambiguous between an active and a passive structure?

(3) Do the three groups react to active and passive morphosyntactic cues and if yes, when?

2.3.2 Participants

Participants were twenty-four 7-year-old monolingual German-speaking children (17 female and 7 male; age range = 6.6 to 7.8; mean age 7.1 years, SD = .4775), twenty-five 10-year-old monolingual German-speaking children (13 female and 12 male; age range = 9 to 11; mean age 10.1 years[8]) and twenty-seven German adult native speakers (20 female and 7 male). The 7-year-olds and 10-year-olds were in the first and fourth year of the German primary school system respectively, whereas the adults were university students. Children were recruited and tested in schools and after-school care centers in Osnabrück and Berlin, and adults at the University of Osnabrück. All participants had normal or corrected-to-normal vision and were naïve as regards the purpose of the experiment. For their participation in the study, the children got a child-friendly certificate and the adults received extra university credits.

[8] For the 10-year-olds, we do not provide standard deviation since we did not collect information on their birthday and thus only have their age expressed in years.

2.3.3 Materials

Sixteen experimental sentences were created. Each sentence was presented either in the active (3), (4) or passive voice (5), (6) (within-subject experimental condition) and started either with a masculine NP (3), (5) or a feminine NP (4), (6) (inter-subject counterbalancing condition), leading to four experimental lists. The full set of sentences divided into these four lists can be seen in Appendix B.1.

(3) Active, first NP = masculine
Der Opa hat am Abend die Oma ganz kurz gekitzelt
The grandpa-SMASC/AGENT has-AUX in the evening-ADV
the grandma-OFEM/PATIENT very shortly-ADV tickled-PPART
'The grandpa has tickled the grandma in the evening very shortly'

(4) Active, first NP = feminine
Die Oma hat am Abend den Opa ganz kurz gekitzelt
The grandma-SFEM/AGENT has-AUX in the evening-ADV
the grandpa-OMASC/PATIENT very shortly-ADV tickled-PPART
'The grandma has tickled the grandpa in the evening very shortly'

(5) Passive, first NP = masculine
Der Opa wurde am Abend von der Oma ganz kurz gekitzelt
The grandpa-SMASC/PATIENT was-AUX in the evening-ADV by
the grandma- OFEM/AGENT very shortly-ADV tickled-PPART
'The grandpa was tickled by the grandma in the evening very shortly'

(6) Passive, first NP = feminine
Die Oma wurde am Abend von dem Opa ganz kurz gekitzelt
The grandma-SFEM/PATIENT was-AUX in the evening-ADV
by the grandpa-OMASC/AGENT very shortly-ADV tickled-PPART
'The grandma was tickled by the grandpa in the evening very shortly'

For active and passive sentences, the first morphosyntactic cue is the case-marked first NP. In half of our experimental items, this NP was feminine and in the other half, it was masculine.[9] Case-marking is ambiguous between nominative and accusative for feminine, but unambiguous for masculine nouns. As summarized above, previous research has shown that listeners tend to analyse initial NPs as agents even if case-marking is ambiguous (Knoeferle et al., 2005). The first disambiguating morphosyntactic cues for actives and passives are the second constituents, the auxiliaries, *hat* 'has' and *wurde* 'was'. Both auxiliaries are reliable cues to indicate actives and passives. The second disambiguating cue for active is an accusative-marked second NP (again, case-marking is ambiguous for half of the items and unambiguous for the other half), and for passive the *by-phrase* including the dative-marked NP. Both structures end with the lexical non-finite verb, the past participle that confirms the respective finite verbs as auxiliaries. In constructing the items, we were careful to choose verbs and actors that resulted in semantically reversible sentences in order to avoid participants using semantic cues for the assignment of thematic roles. We chose eight verbs expressing actions happening between an animate agent and an animate patient and positioned in a semantic continuum ranging from positive to negative actions. The verbs were *küssen* 'kiss', *streicheln* 'caress', *kitzeln* 'tickle', *waschen* 'wash', *wecken* 'wake up', *schubsen* 'push', *treten* 'kick' and *hauen* 'beat'. Four pairs of agent/patient composed of a masculine and a feminine NP were used: *Mann/Frau* 'man/woman', *Opa/Oma* 'grandpa/grandma', *Vater/Mutter* 'father/mother' and *Bruder/Schwester* 'brother/sister'. Each verb appeared twice and each character pair four times within a list, so that all characters had the role of agent and patient in both passive and active sentences. Two to three-syllabic adverbials were added for each item, one temporal adverbial after the auxiliary and one manner adverbial before the past participle. This ensured some time to measure the effect of a given grammatical cue during sentence processing before the onset of the next cue. The sentences were read by a female native German speaker with normal declarative intonation and speed. All trials were digitally recorded with a

[9] In this study the first masculine or feminine NP is an inter-subject counterbalancing condition. Participants were presented with only one of the conditions. As separate analysis for the two gender conditions did not reveal systematic differences and for the purpose of the present study, we do not consider these variables in the analysis.

high quality microphone in a sound-proof chamber into a computer. The experimental sentences were cross-spliced to prevent active/passive cue-intonation from contributing to disambiguation. The first NP and the manner adverbial together with the past participle of active sentences were spliced into passive sentences and vice versa (counterbalanced). For the visual context, pairs of pictures were created illustrating the action described in the sentence once with congruent and once with incongruent assignment of thematic roles. A total of sixteen pairs of pictures were thus used. In the picture pairs, the agent appeared to the left and right of the patient equally often, and each of the eight characters was also presented on the left or right in the pictures an equal number of times. All pictures were drawn to be the same size and did not contain any visual cues which could make one picture more attractive than the other. The picture set was divided into two interest areas, namely the target picture and the competitor picture. The target picture showed the correct distribution of thematic roles, and the competitor picture the reverse distribution. The target picture was shown on the left in half of the trials and on the right in the other half.

An example of a visual stimulus is provided below:

Figure 1: example of a picture for experimental item 1.

Twelve warm-up items were constructed in which participants had to select the correct picture of two based on a verbal prompt (e.g. they heard *Das ist der Opa* 'This is the grandpa' and were presented with two pictures, one showing a grandpa and the other showing a grandma). The aim was to introduce the characters to the participants and to familiarize them with the eye-tracking task. Eight of the characters in the warm-up items corresponded to the characters in the experimental items and four were proper names referring to the characters in the sixteen filler items. The fillers

were distributed among the experimental items to prevent participants from guessing the purpose of the experiment and from developing any response strategies. They consisted of sixteen transitive sentences containing the three different modal verbs *sollte* 'should', *musste* 'had to' and *wollte* 'wanted to'. The experimental sentences were organized into four stimulus lists. For each list participants listened to sixteen experimental items (eight active and eight passive items), sixteen filler items and twelve warm-up items. Since each experimental item was presented in four conditions, sixty-four experimental sentences were constructed (in Appendix B.2 the filler and warm-up items are provided). The same pair of pictures was used for all four versions of each experimental item. For the warm-up and filler items, respectively six and sixteen pairs of pictures were created (the complete set of pictures is provided in Appendix B.4).

2.3.4 Procedure

Participants were tested individually in a university laboratory (10-year-olds and adults) or in a quiet classroom in one of several schools (7-year-olds) under good lighting conditions. Eye movements of the 10-year-olds and adults were recorded using an SR Research Eyelink I eye-tracker (SR Research, Toronto, Ontario, Canada). The experiment was programmed with using SR Research's Experiment Builder Software of SR Research. Visual stimuli were all the same size (jpegs measuring 415 x 315 pixels) and were presented on a 21-inch multi-scan DELL colour monitor at a resolution of 1024 x 768 pixels.

The 7-year-olds were tested using the Tobii X1 Light Eye-tracker. Visual stimuli were WMV files with a resolution of 313 x 192 pixels created using Windows Movie Maker 2.6[10] and were presented on an external 21-inch Samsung monitor at a resolution of 1920 x 1080. Gaze data was logged by the Tobii Studio software running on a DELL netbook positioned in front of the experimenter.

Subjects were seated about 50 cm from the eye-tracker screen and the experimenter sat on their right. In the experiments with the Eyelink I eye-tracker

[10] Due to programming reasons, the stimuli consisted of separate pictures and audio files for the Eyelink I, and video clips for the Tobii X1 Light Eye-tracker. Nevertheless, from the perspective of the participants, the result was identical in these two cases.

viewing was binocular, but only the right eye was recorded; in the experiment with the Tobii X1 Light Eye-tracker both eyes were recorded. Before the start of the experiment, participants were instructed to listen to the sentences until the end and then to select the picture which matched the given sentence by pressing one of two buttons on a keyboard (*Visual Word Paradigm*, Tanenhaus et al., 1995). This provided us with the accuracy results. Before the start of the experiment, participants were manually (Eyelink I) and automatically (Tobii X1 Light Eye-tracker) calibrated using a nine-point gaze fixation pattern and, when requested by the system, a re-calibration was carried out between the trials. The eye-link software validated the calibration and, if it was poor, it was repeated. In the experiments with the Eyelink I, each item was manually started by the experimenter by pressing a button on the keyboard when the participant fixed their gaze on the dot on the screen at the end of every trial. This allowed the eye-tracking software to perform a drift correction if necessary. In the experiment with the Tobii X1 Light Eye-tracker, participants were shown a rewarding picture after every experimental video, and were not asked to fix their gaze on a dot on the screen. The visual stimuli were presented 2500 ms prior to the auditory stimuli. This gave participants the chance to inspect the pictures and thus construct a mental representation of the visual context before listening to the verbal stimulus without being overburdened by the simultaneous presentation of the two types of stimuli. Since the duration of preview time suggested by previous literature varies from study to study, we chose a time that was used in other eye-tracking studies with children (e.g., Marinis & Saddy, 2013; Stromswold, under review). Sentences were presented via two loudspeakers. The experiment lasted approximately 20 minutes.

2.3.5 Coding

For the analysis of the eye-tracking data, the experimental sentences were divided into four main time segments. The reference point for the start of the analysis was the onset of the sound file. The subsequent time segments were determined on the basis of the onset of the critical morphosyntactic cues, namely the two auxiliaries (onset 1),

the second NP (for actives) or the by-phrase (for passives) (onset 2) and the past participles (onset 3).

Table 2 provides an overview of the time segments:

	Time Segment 1	**Time Segment 2**			**Time Segment 3**		**Time Segment 4**
	Sentence Onset 200+500ms (1stNP)	**Onset AUX 0-200ms**	**200-500ms**	**500-900ms**	**Onset 2nd NP/by-phrase 200-700ms**	**700-1200ms**	**Onset PPART 200-500ms**
ACTIVE	Der Opa	hat am Abend			die Oma ganz kurz		gekitzelt
PASSIVE	Der Opa	wurde am Abend			von der Oma ganz kurz		gekitzelt

Table 2: Time segments (Study 1), selected on the basis of cue onset

Onsets were calculated on a sentence-by-sentence basis. Since the programming and the execution of a saccade takes place 200 ms after the reception of the associated verbal input (Matin, Shao, & Boff, 1993; Rayner, 1998), statistical analysis for each time segment began 200 ms after the onset of the time segment. The length of each time segment was established taking into consideration the average, earliest and latest onset of the subsequent cues in the next time segment.[11]

Time segment 1 lasted 500 ms because we calculated that the earliest onset of the first cue, the auxiliaries *hat* and *wurde* occurred at 538 ms. With a segment length of 500 ms, we were sure that the effects during the first segment were the results of the first NP alone and not of the following auxiliaries. Time segment 2 lasted 900 ms as the earliest onset of the following cues, the second NP/*von*-phrase occurred at 733 ms and, as mentioned above, 200 ms is the time necessary to program and the execute a saccade. In this way any effects triggered by the second NP/*von*-phrase were not included in this time segment since they would have been visible starting from 933 ms. Time segment 3 lasted 1200 ms since the onset of the last cue, the past participle, occurred at 948 ms and this, added to the 200 ms, resulted in 1148 ms. This indicated that in few cases, the last 52 ms of time segment 3 might be affected by the onset of the past participle. However, since the last part of the time segment was not fundamental for our analysis, we decided to make it last 1200 ms.

[11] Earliest, mean and latest time of, respectively, Onset 1 (auxiliaries), 538, 840, 1124 ms; Onset 2 (2nd NP or *by*-phrase), 733, 976, 1233 ms; and Onset 3 (past participles), 948, 1269, 1692 ms measured from the previous onset.

Two of the four main time segments, the second and the third, were further split into smaller periods. The second time segment including the first disambiguating cues was further divided into three parts in order to have a more precise view of the time course of the gaze fixations, given that many processes have been observed to take place in this segment. The first part included the time before the auxiliary recognition, from the onset until 200 ms, then from 200 ms until 500 ms and from this last time point until 900 ms, roughly before the start of the subsequent third time segment. The third time segment including the second disambiguating morphosyntactic cues was split in two parts, 200-700 ms and 700-1200 ms.

During the first time segment, there are no morphosyntactic cues available to the listeners enabling them to disambiguate the sentence as an active or passive, so that we expect that participants do either make use of no strategy or interpret the first NP as agent of the sentence, thus relying on the "agent-first strategy". The second time segment includes instead the first disambiguating morphosyntactic cues, namely the active and passive auxiliaries. At this sentence point, if participants are sensitive to morphosyntax, we expect them to start fixating more the target picture of respectively active and passive sentences. Time segment 3 includes the second disambiguating cues, so that we expect participants to either continue interpreting correctly the sentences, if they were already on the right track in the antecedent segment or to use them to start disambiguating them. The last segment is a further disambiguating cue, as it confirms the previous finite verbs *hat* and *wurde* as auxiliaries of a present perfect and a past passive, respectively for the active and passive voice.

Both accuracy and eye movement data were analyzed with logistic mixed effect models using R (R development Core Team, 2012) and the R packages *lme4* (Bates, Mächler, Bolker, & Walker, 2015) and *languageR* (Baayen, 2008).

In the results section, we will report the results for each time segment. Effects of interest for our research question are main effects of Image or interactions between Image and Sentence Type, Image and Age, or a three-way-interaction between Image, Age and Sentence Type. A main effect of Image means that the subject's gaze was fixed on correct and incorrect images to significantly different degrees. An interaction of Image and Sentence Type would indicate that the preference for the correct over

the incorrect image (or vice versa) is not the same in the two experimental conditions. In addition, it might also point to a difference robustness of the same interaction between the groups. Finally, interactions with Age indicate that these effects differed between age groups.[12] All effects for each time segment are reported in Appendix D.1.

Possible eye movement patterns

If children look at the target and competitor picture equally often (50% target looks), then this does not allow for any conclusions regarding their processing strategies. If they look at the target picture more than 50%, this means that they are using a strategy that leads to the correct interpretation of the sentence. On the other hand, if they look at the target picture less than 50%, this means that they are using a strategy that does not lead to the correct interpretation of the sentence. We expect to see differing scores for actives and passives, if children make use of an "agent-first strategy", being thus on the right track during actives but not during passives. If the percentage difference from the 50% level is greater for one of the two sentence types, this means that there is a cue in one of the two conditions that they are making greater use of.

2.3.6 Results

2.3.6.1 Accuracy

The 7-year-olds were almost equally accurate in selecting the congruent picture during actives and passives, with a mean accuracy rate of 94.2% for active and 93.2% for passive.[13] The 10-year-olds reached similar results with a mean accuracy rate of

[12] We will not discuss main effects of Age, Sentence type or interactions of Sentence Type and Age, as we have no hypotheses for these factors.

[13] 16 trials in total (8.7%) were excluded from the analyses of the 7-year-olds. 14 trials elicited no answer (7.6%), seven in the active and seven in the passive condition, and two trials during actives were classified as "trial skipped" (1.1%), because no eye gazed was detected, probably because participants pressed the key too long, and the program moved on to the next trial.

94.4% for active and 95.4% for passive.[14] The adults performed almost at ceiling in both conditions with a mean response accuracy of 98.1% for active and 97,7% for passive.[15]

For the accuracy data, the dependent variable was whether participants chose the target or competitor picture. The model contained Age (7-year-olds, 10-year-olds, adults), Sentence Type (active, passive), their two-way interaction and participants and items as random factors including individual slopes for Age and Sentence Type (lmer and binomial family in R) (Jaeger, 2008; Baayen, 2008; Barr, Levy, Scheepers, & Tily, 2013). We found a main effect of Age (estimate = 3.3797, std. = 1.3101, z = 2.580, p = 0.01) due to a significant difference between the 7-year-olds and the adults. No additional main effects and interactions reached significance. This finding reflects the fact that adults are more accurate than 7-year-olds.

2.3.6.2 Eye movement data

In the following, for the eye movement data, the dependent variable was the sum of gaze fixations on the target or competitor picture, specifically for cases where participants correctly interpreted sentences. We analysed participants´eye movements only for the trials they got correct as we found that the groups were overall highly accurate. By including only correct trials in the analysis, we could focus on the question whether participants with correct off-line interpretation revealed different strategies or more difficulties in processing the cues during on-line processing. In addition, trials with recording problems (e.g. track loss, trials skipped) and inaccurate responses were excluded from the analyses. At every 20 ms it was determined whether gaze had been fixed on the target or competitor picture (Järvikivi, Pyykkönen-Klauck, Schimke, Colonna, & Hemforth, 2013). The sum of these gaze fixations was then computed for each time segment.

For all data sets, we first computed a full model including the fixed factors and their three-way interaction, Age (7-year-olds, 10-year-olds, adults), Image (correct,

[14] Five trials in total (2.5%) were excluded from the analyses of the 10-year-olds. One trial (0.5%) provided no answer. Four trials (2%), one for active and three for passive, were marked as skipped trials because no eye gazed was detected, probably again because participants pressed the key too long.
[15] Six trials in total (1.4%) were excluded from the analyses. One trial (0.2%) elicited no answer and computer failure occurred during five trials (1.2%) three in the active condition and two in the passive.

incorrect) and Sentence Type (active, passive), as well as participants and items as random effects including random slopes by participants and by items for all fixed factors and their interactions (Baayen, 2008; Barr et al., 2013; Jaeger, 2008). Given that the Age factor included three levels, the 7-year-olds were selected as the base group against which the 10-year-olds and the adults were compared. In cases where the full model did not converge, interaction terms were removed from the random slopes of the model. The first converging model was defined as the maximum model, against which all simpler models were compared by log-likelihood ratio test with the anova function in R (see e.g. Barr et al., 2013). Model comparisons assured that the model containing the interactions was a significantly better fit to the data than a simpler model with just the three main effects. In all analyses presented in the following, the full model with all fixed effects and their interactions proved to be better than simpler models.

Plots of the three age groups' fixation patterns during the full time-course of the trials per conditions are displayed in Figure 2. The figure displays the percentage of gaze fixations on the target picture out of all fixations on either the target or competitor picture for the full time-course of the experimental sentences. An examination of Figure 2 suggests that participant gazes at target images do not fall to chance level at any time during the processing of the sentences. From the onset of the sentences until the end, participant gaze fixations fluctuate between the target and competitor picture, revealing their on-line preferences in assigning thematic roles.

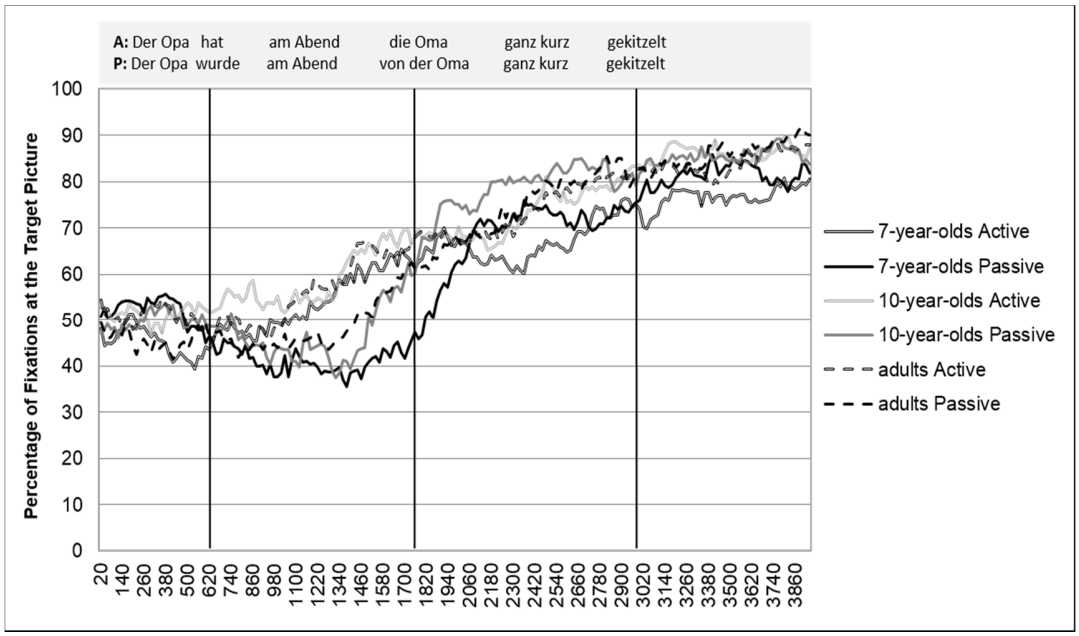


Figure 2: Plot of age-group averages for gaze fixations from start to finish of trial (active and passive sentences, correct trials only), showing percentages of fixations directed at the target picture

Time segment 1: nominative NPs (der Opa/die Oma)

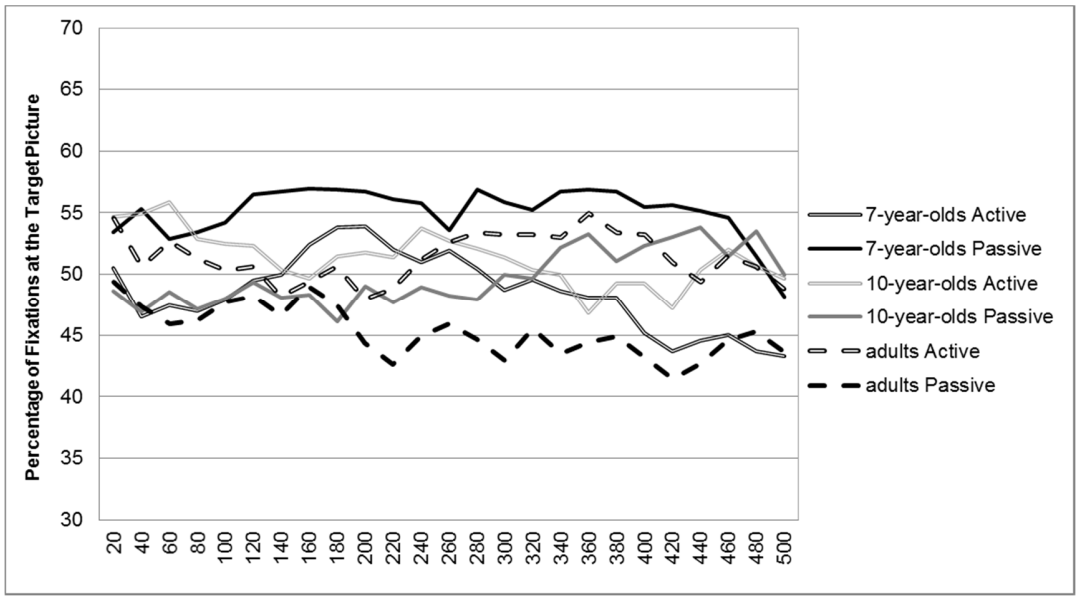


Figure 3: Gaze fixation during Time Segment 1: plot of age-group averages for gaze fixations from start of trial (active and passive sentences, correct trials only) until 550 ms, showing percentages of fixations directed at the target picture

The first time segment includes the time when participants heard the first NP without yet having any cue available to disambiguate the sentence as an active or passive

sentence. We found a three-way interaction between Image, Age, Sentence Type in both age group comparisons (7 vs. 10 year olds and 7 year olds vs. adults). To investigate the origins of this interaction, we computed subsequent models testing Image, Sentence Type and their interaction separately for each of the age groups. For the 7-year-olds, we found a significant interaction between Image and Sentence Type, due to the fact that there were more gazes directed at the target than to the competitor picture for passive sentences, while the reverse was true for active sentences. In separate analyses of the effect of Image for the two sentence types, this effect did not reach significance for either active or passive sentences, however. There were no significant effects in the 10-year-olds. The analysis of the adult data revealed an interaction of Image and Sentence Type. Contrary to the 7-year-olds, this was due to more gazes being directed at the target picture for active sentences, but more gazes being directed at the competitor picture for passive sentences. Yet, in separate analyses of the effect of Image for the two sentence types, this effect did not reach significance for either active or passive sentences.

Discussion: Time segment 1

The results show that only the adults started immediately to process the sentences with an "agent-first strategy". The 10-year-olds made use of no strategy at all and the 7-year-olds instead adopted a "patient-first strategy". The finding that the 7-year-olds were looking more at the target picture during passives than actives, that is, they were looking more at the picture in which the referent mentioned during the first NP was the patient, is a surprising behavior which we did not expect. This might suggest that our younger children consider the role of the protagonist who underwent an action, the patient, more salient than the role of the actor who fulfills the action. A similar finding can be observed in a study on pronoun resolution with 3-year-olds. Pyykkönen, Matthews, and Järvikivi (2010) monitored the eye movements of English-speaking children while they listened to a sentence starting with a pronoun that referred to a previous sentence containing a subject and an object including either high or low transitivity verbs. While they found a general preference to look at the subject in both conditions when the children listened to the pronoun, they also found

an initial preference to look at the object, which was then quickly revised in favour of the subject.

The lack of strategy by the 10-year-olds may have a similar explanation to what Stromswold (under review) observes in 6-year-olds. She suggests that this age group has learnt, contrary to the 5-year-olds, that not all first NPs are agents and therefore waits for additional information. This explanation is not supported by the findings for German-speaking adults, however, who were shown to start processing the sentences with an "agent-first strategy" (Kamide et al., 2003; Knoeferle et al., 2005). However, unlike what was seen in Knoeferle et al.´s study, the adults in the present study assigned the thematic roles already during the first NP and did not wait until the onset of the finite verb. To mention is, however, that in the study they only made use of feminine NPs whereas we used both masculine and feminine first NPs. Even if we did not find any differences in the separate analysis per gender of the first NP, it would be interesting to investigate in further studies whether children start to use the "agent-first strategy" at different times according to the case-marking of the first NP (either masculine, that is unambiguously nominative or feminine/neuter, that is ambiguous between the nominative and accusative case).

Time segment 2: auxiliaries (active, hat; passive, wurde)

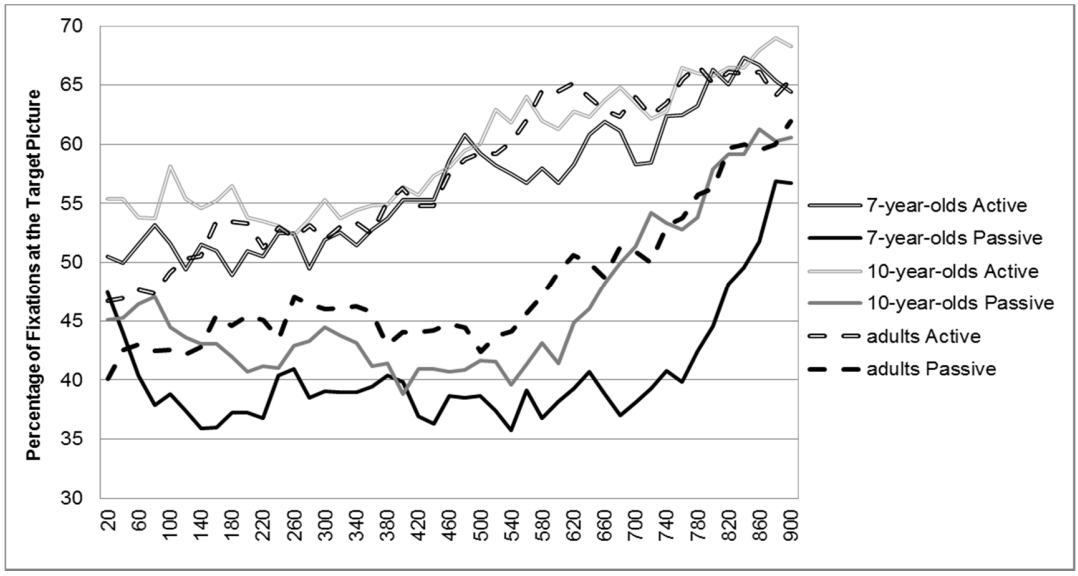


Figure 4: Gaze fixation during Time Segment 2: plot of age-group averages for gaze fixations from the onset of auxiliaries until 900 ms (active and passive sentences, correct trials only), showing percentages of fixations directed at the target picture

0-200

During the first part of Time Segment 2, participants listened to the first disambiguating cue, the auxiliary *hat* or *wurde*. We assume that this segment does not include any effects caused by the auxiliaries as 200 ms is roughly the time required to account for the programming of a saccadic eye movement (Matin, Shao & Boff, 1993; Rayner, 1998), so the effects must be considered spillover effects of the preceding time segment. We found an interaction between Image and Sentence Type with no additional main effect of Image. There was no three-way-interaction with the factor Age, suggesting that the two-way-interaction was present in all three age groups in a similar manner. The significant interaction reflects a higher number of gazes directed at the target picture during actives than during passives. Separate analyses of the main effect of Image separately per Sentence Type showed no significant effects for actives, but a significant main effect of Image for passive sentences, due to more gazes being directed at the incongruent than at the congruent picture.

200-500

The effects seen in the second part of the second time segment may be interpreted as a reaction to the auxiliaries. There was a significant three-way interaction only when the 7-year-olds and adults were considered, whereas for the 7-year-olds and the 10-year-olds, the interaction achieved no significance. Separate analyses per age group revealed for the 7-year-olds a significant interaction between Image and Sentence Type with no additional main effect of Image. Further separate analyses per sentence type showed a main effect of Image during passives and not during actives. These two effects – the interaction together with the main effect of Image in the separate analysis of the passive trials – show that the tendency of the 7-year-olds to prefer one picture over the other (the target over the competitor for active sentences, and the competitor over the target for passive sentences) was more robust in the passive condition. For the adults we found a significant interaction between Image and Sentence Type as well, with no additional main effects of Image. Separate analyses of the effect of Image for the two sentence types showed no significant effects. Similarly to the 7-year-olds, the adults looked at the target picture more during actives than

during passives. The absence of a main effect of Image in the separate analyses reveals the lack of a significant preference for one of the two pictures in both conditions, however.

500-900

In the third part of the second time segment, we found a main effect of Image and a significant three-way interaction only when the 7-year-olds and the adults were considered and not when the 7-year-olds and the 10-year-olds were analysed. Separate analyses per age group revealed for the 7-year-olds a significant interaction between Image and Sentence Type with no additional main effect of Image. Separate analyses per Sentence Type showed a main effect of Image during both actives and passives. The interaction and the significant main effects of Image in the separate analysis reflect the high degree of gaze fixations on the target picture during actives and on the competitor picture during passives. For the adults, we found a significant interaction between Sentence Type and Image as well, with no additional main effect of Image. Separate analysis showed a significant effect of Image during actives, but not during passives. The lack of a main effect of Image during passives reveals that the number of gazes directed at the competitor picture during passives was not as high as the number of gazes directed at the target picture during actives.

Discussion: Time segment 2

During the first part of the time segment (0-200), the significant interaction between Image and Sentence Type in all three groups suggests that at this point in processing, the child groups started to make use of an "agent-first strategy". This strategy cannot be an effect of the auxiliary, given that the programming and execution of eye movements in response to auditory stimuli take between 180 ms and 250 ms (Matin, Shao & Boff, 1993; Rayner, 1998), but must still be an effect of the processing of the first NP. The presence of the interaction in all groups also reveals that the 7-year-olds reversed the initial strategy shown in time segment 1, while the 10-year-olds started to make use of a strategy. The "agent-first strategy" was similarly pronounced in the three groups, as shown by the absence of any significant interaction with the factor Age.

During the second part of the time segment (200-500), the three-way interaction was significant only when the 7-year-olds and adults were considered and not when the 7-year-olds and 10-year-olds were considered. In analyses separated by Sentence-type, there was a main effect of Image for passive sentences in the 7-year-olds, but not in the adults, suggesting that in this time window, the "agent-first strategy" was more pronounced in this group. The same robust "agent-first strategy" was shown by the 10-year-olds, who thus did not differ significantly from the 7-year-olds. In addition, the lack of a main effect of Image during actives suggests that both the 7-year-olds and the adults were still not making a pronounced use of the first morphosyntactic cue to an active sentence, the auxiliary *hat.* During the third part of the time segment (500-900), the significant three-way interaction was again only significant when the 7-year-olds and adults were considered. However, differently from the previous part, there was a significant main effect of Image in both groups during actives, and again a significant main effect of Image during passives for 7-year-olds, but not for adults. For the adults, the significant main effect of Image during actives indicates that the adults started to exploit the auxiliary *hat*, and thus looked significantly more often at the target than at the competitor picture. For the 7-year-olds, the same main effect of Image might be interpreted as either a reaction to the auxiliary or still a result of the "agent-first strategy". The second explanation is due to the fact that the main effect of Image was also significant during passives, indicating that while the target picture was looked at more during actives, the competitor picture was looked at more during passives, in line with an "agent-first-strategy". There was again no significant three-way-interaction when the 7- and 10-year-olds were considered. Nevertheless, an examination of Figure 4 above suggest that the 7-year-olds started later than the 10-year-olds to react to the passive auxiliary *wurde*, that is, to revise their interpretation of the sentence. Put differently, the 10-year-olds abandoned the "agent-first strategy" faster than the 7-year-olds. In addition, unlike in the previous two parts of Time Segment 2, a main effect of Image was found, indicating that in this segment, the target picture was looked at overall more than the competitor picture.

Time segment 3: active, accusative NP; passive, von-phrase

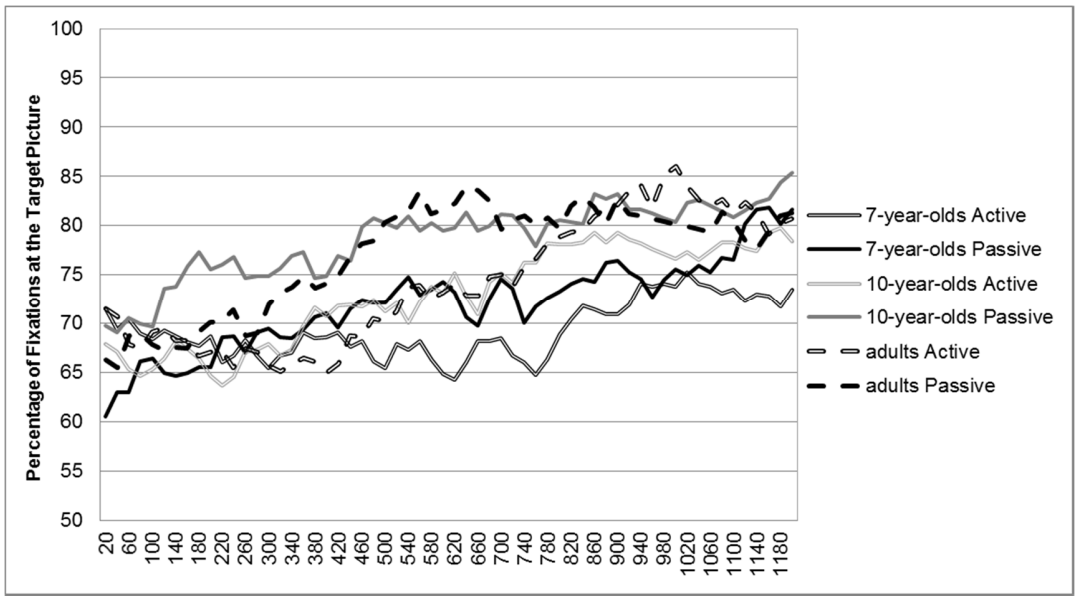


Figure 5: Gaze fixation during Time Segment 3: plot of age-group averages for gaze fixations from the onset of the second NP or by-phrase until 1200 ms (active and passive sentences, respectively, correct trials only), showing percentages of fixations directed at the target picture

200-700

In the first part of the third time segment, we found a main effect of Image and a three-way interaction of Image, Age and Sentence Type only when the 7-year-olds and 10-year-olds were considered. Separate analysis of the interaction per age group revealed for both the 7-year-olds and the 10-year-olds a significant interaction of Image and Sentence Type. Separate analyses of the factor Image per Sentence Type showed a main effect of Image for both active and passive sentences in both groups. The interaction is due to the fact that even though the target picture was looked at in the clear majority of cases for both active and passive sentences, the passive sentences led to more gazes being directed at the correct picture than during actives. Moreover, this difference in strength was more pronounced in the 10-year-olds than in the 7-year-olds, which explains the significant three-way-interaction.

700-1200

In the second part of the third segment, we found a main effect of Image and an interaction of Image and Sentence Type. Separate analysis of the interaction per

Sentence Type revealed a main effect of Age and no significant interaction between Image and Age in both actives and passives. The significant interaction reflects the higher number of gazes directed at the target picture during passives than during actives.

Discussion: Time segment 3

At this point all groups have reached the correct interpretation. The gaze pattern that emerges in this time segment indicates a stronger preference to look at the target picture during passives than actives. The slow increase in directed gazes after the onset of the second disambiguating active cue may indicate that both children and adults have not felt challenged by the active sentences. In the active condition, participants may feel so sure of their interpretation that this leads to more gazes being directed randomly at either picture.

Time Segment 4: past participles

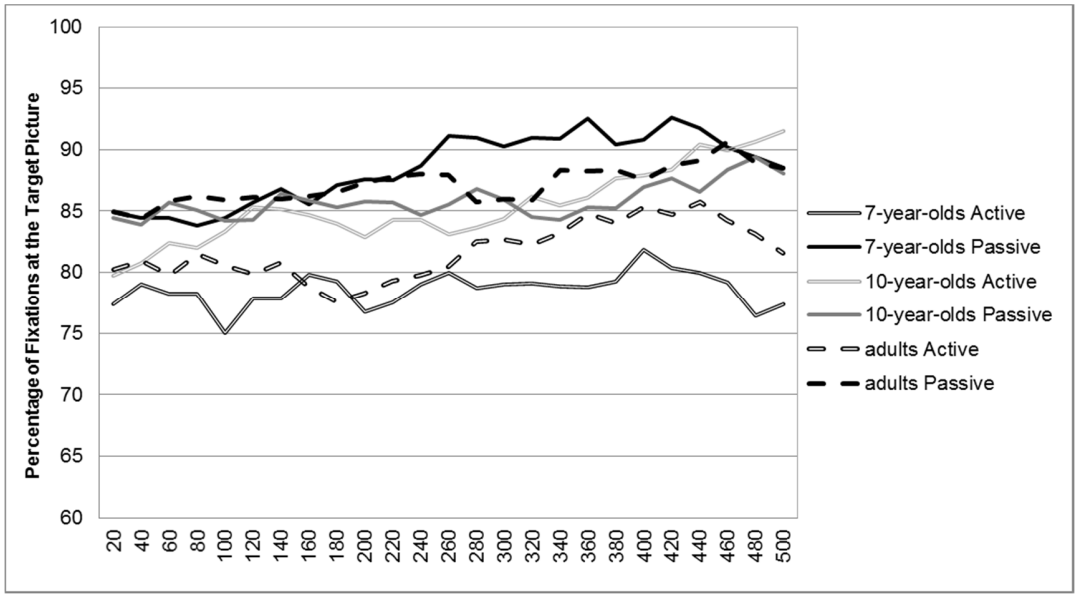


Figure 6: Gaze fixation during Time Segment 4: plot of age-group averages for gaze fixations from the onset of the past participle until 500 ms (active and passive sentences, correct trials only), showing percentages of fixations directed at the target picture

After the onset of the past participle, we found a main effect of Image and a three-way interaction of Image, Sentence Type and Age only when the 7-year-olds and 10-year-olds were considered. Separate analysis of the interaction per age group revealed

only for the 7-year-olds a significant interaction between Image and Sentence Type. Separate analyses of the factor Image per Sentence Type showed a main effect of Image for both active and passive sentences.

Discussion: Time segment 4

Similarly to the previous time segment, a more pronounced preference for the congruent picture during passives than actives was maintained by the groups except for the 10-year-olds, whose main effect of Image only suggests a preference for the congruent picture even more so during actives.

2.4 General Discussion

In the present study we collected eye movement data as German-speaking 7-year-olds, 10-year-olds and adults listened to reversible active and passive sentences and performed a picture-matching comprehension task. Our research questions concerned 1) the off-line interpretation of active and passive sentences by the three groups; 2) the strategies used while processing sentences when they were still ambiguous between an active and a passive structure; and 3) whether and when they reacted to the active and passive morphosyntactic cues. In answer to the first research question, the present study corroborates previous off-line findings showing that children have almost no difficulties in comprehending reversible passive sentences at age 7 (Aschermann et al., 2004; Dittmar et al., 2014; Grimm, 1975; Mills, 1977). As for the strategies adopted by the three groups, significant differences were encountered between the 7-year-olds and the adults in the most relevant time segments. The second question, concerning the use or not of the "agent-first strategy" before the sentence disambiguation between an active and a passive sentence, and the third, on the exploitation of active and passive morphosyntactic cues, will be answered in detail in the remainder of the discussion.

The early use of the "agent-first strategy"

Only the adult group displayed an early use of an "agent-first strategy" already during the first NP. On the other hand, the 7-year-olds instead showed a "patient-first strategy" and the 10-year-olds showed no use of a strategy while processing the first NP. Even if the "agent-first strategy" was adopted by all three groups at the beginning of the second time segment, slightly before the processing of the auxiliaries, the question remains open as to why adults show such an early "agent-first strategy" in comparison to the child groups. This quick use of the strategy might be due to the adults´ quick processing mechanisms (Cerella & Hale, 1994; Kail, 1991), as also shown by the rapid integration of syntactic and semantic information for predictive processing (Kamide et al., 2003). According to these studies, processing speed is observed to increase considerably in early and middle childhood as a result of brain maturation (Lenroot & Giedd, 2006).

While during the first NP the 7-year-olds tended to look more at the patient of the action, the 10-year-olds did not make use of any strategy at all and looked at both pictures. They behaved similarly to the 6-year-olds in Stromswold's study, who did not assign any thematic role during the first NP. Stromswold explained the findings by arguing that the 6-year-olds "have grown enough that they can afford to wait for additional information before assigning a thematic role to the first NP of a sentence" (Stromswold, under review: 56). However, with the onset of the English passive auxiliary *was*, which in English is not the first disambiguating cue and is the same auxiliary as that used in the active counterpart, the 6-year-olds revealed a slight "agent-first strategy". The author explains it as an interpretation of *was,* being a more frequent cue, as signalling an active (past continuous, "*was* + present participle") rather than a passive sentence (past passive, "*was* + past participle"). In contrast, we propose that the processing behaviour of Stromswold's 6-year-olds might also be the result of a later "agent-first strategy" like that displayed by our 10-year-olds. Furthermore, Stromswold's adults did not make use of any strategy at first and waited for more information before assigning any role. This last finding in English compared to the opposite pattern of our German adults is particular interesting in view of the debate on the role played by the statistical properties of the input language. According to Bates and MacWhinney (1989)´s *Competition Model*, the presence of only few case-marking inflections in English (only personal pronouns, e.g. *I* nominative, *me* accusative), makes the ordering agent-before-patient highly valid (even if it is not 100% reliable) to mark the first NP as the agent. German, on the other hand, has a richer amount of inflectional markers to encode syntactic and semantic relations, so that variations from the canonical word order are more frequent. According to this prediction, German speakers would be expected to make use of the "agent-first strategy" less than English speakers. The present findings compared to those of Stromswold et al. (2002) study show the opposite pattern, indicating that the „agent-first strategy" is considered a reliable strategy more often in German than in English. However, Kamide et al. (2003) revealed a similar "nominative-first preference" for English adults at least during the disambiguating verb region. Importantly, they did not provide eye-tracking data for the time segment during the first NP, so that we do not know exactly whether they made use of an

"agent-first strategy" from the outset, behaving thus differently from Stromswold's adults. Further research is needed to clarify the influence of language-specific properties on processing strategies.

The intensity of the "agent-first strategy"

We found that the "agent-first strategy" does not occur at the same time in all three groups, but is visible in all groups in the second time segment. As described above, significant differences were detected between the 7-year-olds and the adults in the second part of the second time segment, after the processing of the first disambiguating cues, the auxiliaries *wurde* and *hat*. This difference concerns the degree of application of the "agent-first strategy", which was more pronounced for the 7-year-olds than for the adults. Specifically, the 7-year-olds showed a significant preference for the competitor picture in the passive trials which was not present in the adults. Despite the lack of significant difference between the 7-year-olds and the 10-year-olds, Figure 4 clearly shows that descriptively, the 7-year-olds showed a more pronounced "agent-first strategy" than the 10-year-olds. We interpreted this difference in the use of the "agent-first strategy" as evidence of a learning process, with children learning to assign a different value to a strategy which is not always reliable. These on-line findings are in line with the pattern found in the previous off-line studies on the comprehension of passives (Aschermann et al., 2004; Dittmar et al., 2014; Grimm, 1975; Mills, 1977) which provided evidence that in the course of their linguistic development children pass through a phase in which they over-rely on the "agent-first strategy" and weight morphosyntactic cues less. As their linguistic development proceeds, their increasing accuracy with reversible passives indicates that they gradually rely more heavily on case-marking.

The time course of reaction to the first passive cue and abandonment of the "agent-first strategy"

The previously mentioned significant difference between the 7-year-olds and adults in the second part of the second time segment does not only reflect the more pronounced "agent-first strategy" of the 7-year-olds in comparison to the adults. It

also mirrors the difference in the time-course for revising the "agent-first strategy" in reaction to the passive cue, which occurred 140 ms later for the 7-year-olds compared to the adults. This difference between the two groups might be explained at the cognitive level by studies on child processing of non-canonical and *garden-path sentences*, showing a tendency for children to hold onto initial misanalysis with subsequent failure to integrate cues, which unfold later in the sentence and which are in conflict with their previous analysis (Choi & Trueswell, 2010; Huang et al., 2013; Huang et al., 2016; Novick et al., 2013; Trueswell et al., 1999). Even if the 10-year-olds were not significantly different to the 7-year-olds, it is descriptively clear that they gave up the "agent-first strategy" before the 7-year-olds and after the adults and/or reacted quicker to the passive cues than the 7-year-olds and slower than the adults.

Note that the pattern found in the abovementioned studies concerns 5-year-old children and *garden-path sentences*, whereas we tested the comprehension of non-canonical passive sentences by 7-year-olds. The fact that 7-year-olds did not fail to revise the initial wrong assignment of thematic role (off-line accuracy: 93.2%), but simply needed more time to integrate the conflicting passive cue into their analysis and/or abandon their strong initial "agent-first strategy" might indicate either that cognitive aspects do not play such a strong role for the 7-year-olds or that the disambiguating passive morphosyntax is a stronger signal than the cues in *garden-path sentences*. If cognitive aspects do play a role, it might be the case that the 7-year-olds have still deficit in inhibitory control. During the processing of passives, these less developed cognitive abilities might be reflected in the children´s longer integration of the auxiliary *wurde*.

In addition, this delayed reaction might again be explained in terms of generally increased reaction times to new cues for children compared to adults (Cerella & Hale, 1994; Kail, 1991). However, this interpretation does not explain the quick and uniform reaction to the active cue *hat* by both the children and the adults. In this regard, we cannot say exactly whether the reaction of the 7-year-olds is, like that of the other two other groups, the result of the auxiliary *hat* or if instead it reflects an expression of the "agent-first strategy".

Another explanation for the longer reaction times of the 7-year-olds in making use of the passive morphosyntactic cue and/or suppressing the initial strong "agent-first strategy" might thus lie in the robust weight that the children assign to the "agent-first strategy". The 7-year-olds find it difficult to abandon this initial preference, when conflicting cues intervene. As the children get older, the weight assigned to the strategy diminishes proportionally to the degree of difficulty to leave it and rely on new conflicting cues.

Implication for a language processing model

This study has shown that 7-year-olds differ in a quantitative way from the adults in relying on the "agent-first strategy" and in the time they need to abandon it. Even if they showed a stronger reliance on this strategy compared to the adults, they were able to revise the sentence, but needed more time to start the revision process. With this study, we can partly contribute to the question posed in Ferreira´s article (2003) on how heuristics and algorithmic systems are coordinated and weighted, at least as far as the the "agent-first strategy" and morphosyntax is concerned.

Our findings suggest that both children and adults start to process sentences by making use of a simple heuristic, the "agent-first strategy" or a "NVN-strategy" in Ferreira's terms, according to which the language processor assumes that the first encountered NP encodes the agent and the second NP the patient. Then, as soon as highly reliable cues conflicting with this strategy are encountered, the processor shows sensitivity to them, so that a syntactic representation of the sentence wins out over a simple heuristic already at age 7.

Our findings are also in line with the conclusions of Snedeker and Trueswell (2004) on the comprehension of English *garden-path sentences* and of Dittmar, Abbot-Smith, Lieven and Tomasello (2008) on German object-first sentences. Both studies come to a similar conclusion, arguing that children are sensitive from the start to multiple cues, and that they weight these cues differently in the course of their development. Specifically, Snedeker and Trueswell (2004) argue that the "child parsing system can in principle use multiple evidential sources to guide a syntactic choice. But in practice the usefulness of particular sources of evidence is a matter of discovery, and hence changes with experience". The different weighting of the

"agent-first strategy" and morphosyntactic cues that we found in our data mirrors this changing reliance on cues throughout development until the achievement of an adult-like mastery (which is also not always flawless) as the result of more experience.

2.5 Conclusion

The study shows that there are differences in development concerning the weighting of the "agent-first strategy" in German. Younger children reveal a stronger use of the strategy compared to the adults. Nevertheless, all three groups overcame this initial incorrect strategy – with slightly different revision times – during the processing of passive sentences. Importantly, in the off-line task, we found that children revealed high accuracy scores, thus suggesting that, despite the different revision times of the "agent-first strategy" and/or reaction to the passives cues, their explicit knowledge of passive sentences is the same.

In contrast to other studies in which younger children (aged 5) have shown difficulties in abandoning a strategy they have committed to at the beginning, this study reports evidence that the reliance on the "agent-first strategy" can be revised by 7-year-olds. We interpreted this behaviour by arguing that by age 7, children are aware that the first NP is not always the agent, and they have more inhibitory abilities than 5-year-olds to revise irrelevant cues in order to achieve a correct sentence interpretation, such as the "agent-first strategy" during passives. However, in order to better understand the role played by inhibitory control capacities and the assignment of thematic roles, it would be important for future research to measure participants' executive abilities and their correlation to sentence revision.

This study provides further evidence that at 7, child processing is more similar to what we see in 10-year-olds. This might suggest that the age of 5 marks a crucial processing stage or transition in a child's linguistic development. Against this background, one interesting question for further research might be to explore how heavily younger German children, such as 5-year-olds, rely on the "agent-first strategy" and how they integrate the passive morphosyntax. Another interesting topic for future research would be to include semantic factors such as animacy in the analysis. While manipulating the animacy of the first NP, we could test whether

participants at different ages revealed a more immediate on-line reaction to the passive auxiliary if the first NP is not animate and thus has more features of a typical patient than an agent.

3 The processing of German passive sentences in monolingual and second language children

3.1 Introduction

The production and comprehension of non-canonical sentences in German are complex and lengthy tasks for both L1 and L2 children; these structures are difficult to master before children enter primary school and continue to challenge young learners during this period (Ehlich et al., 2008). Previous research on these sentences has focused on whether L1 and L2 children produce non-canonical sentences in free conversation (e.g., Wegener, 1998) or in elicited tasks (e.g., Haberzettl, 1998; Schneitz, 2015) and on whether the comprehension of these sentences is target-like (e.g., Becker, 2006; Dittmar et al., 2014).

These studies agree that L2 children who start to acquire the L2 around the age of 3 or 4 begin to produce and understand these sentences later than L1 children. However, from the data available, it seems that L2 children undergo the same developmental stages as L1 children before achieving target-like mastery of these structures. Both groups rely at first on what we refer to as "the agent-first strategy", that is, in both production and comprehension, they prefer to assign to the first NP the category of subject and agent of the sentence. This preference for the agent before the patient corresponds to the most frequent ordering in German declarative sentences and therefore to the pattern that children are most likely to experience as input. Only in a later phase do children start to place less weight on this strategy and come to rely more on other information, such as semantic and morphosyntactic cues (for L1 children: Dittmar et al., 2008; Dittmar et al., 2014; Grimm, 1975; Haberzettl, 1998; Mills, 1985; for L2 children: Becker, 2006; Gamper, 2016; Root, 2014; Wegener, 1998).

As we have noted, in non-canonical sentences the "agent-first strategy" is in competition with morphosyntax. Due to their pronounced reliance on this strategy in the first stages of first and second language acquisition, children avoid the use of non-canonical sentences in production, preferring simpler canonical structures in which

the agent comes before the patient, and mostly misunderstand them in comprehension.

By looking at off-line comprehension data alone, that is, by investigating whether child performance with non-canonical sentences is target-like or not, we can determine whether children have explicit knowledge of the morphosyntactic cues disambiguating the sentences, but we can not know how these cues are weighted during the process of comprehenson. Specifically, we do not have any insights into whether at a particular age children completely stop making use of the "agent-first strategy" and rely on morphosyntactic cues only or whether they still make use of the former and then revise the sentence as soon as conflicting morphosyntactic cues intervene. No studies so far have pursued this question and investigated whether and how the processing of German L1 and L2 children with non-canonical sentences differ in this respect.

In general, processing research has paid little attention to the child L2 processing system; the focus has typically been on how adult L2 learners compute sentential representations in comparison to L1 adults. This question has been extensively investigated by comparing monolingual adults with late second language learners in a range of experiments. However, due to the resulting high variability in the findings, the results of this L2 adult research will not be discussed here.

The investigation of childrens´ on-line processing is of interest in order to obtain a better and comprehensive picture of children's linguistic knowledge. Specifically, even if we discover that children do not understand correctly non-canonical sentences in the off-line task, we still do not know whether they lack linguistic knowledge of the structures or whether other factors might have affected this bad performance. Concretely stated, a child might have difficulties in comprehending one structure during the off-line task yet exploit the cues correctly in the on-line processing. In this context, Marinis (2010) claims that the explicit task of interpreting a sentence after having heard it places more demands on participant executive functions than the on-line implicit task of hearing and simultaneously comprehending the sentence, which is an unconscious and automatic behaviour. Empirical evidence supporting the idea that in general immature executive functions affect off-line performance has been provided by various studies. They show that

even if children are sensitive to grammatical cues during on-line processing, they often fail to keep them in mind until the final interpretation of a sentence due to less-developed working memory capacities (for L1 children: Adani & Fritzsche, 2015; Brandt-Kobele & Höhle, 2010; Huang et al., 2013; for L2 children: Marinis, 2007).

Moreover, the investigation of on-line processing might inform us of a different perspective. We could also learn from the off-line data that participants' comprehension is high – meaning a target-like comprehension of the structure –, but then discover from the on-line data that the children differ in how they make on-line use of the cues. In this perspective, the on-line data would point to children's hidden difficulties and efforts with the structures, which we would not have noticed by considering the off-line data alone.

In the present study, we tested on-line and off-line comprehension of two age groups of L1 and L2 children, 10-year-olds and 7-year-olds. Off-line comprehension was measured with a picture-matching task, whereas on-line processing with the *Visual Word Paradigm* (Tanenhaus et al., 1995). We focused on comprehension of German active and passive sentences, two structures presenting respectively a canonical and a non-canonical ordering of thematic roles (agent-action-patient vs. patient-action-agent) but the same ordering of the syntactic functions (subject-verb-object) (Eisenberg, 2013). The structures are well suited for our current research goal, as they enable us to investigate whether participants rely on the most frequent ordering of thematic roles, agent-before-patient and whether and how they suppress this strategy. Since the first NP in passives mantains the syntactic function of subject like in active sentences, children have to wait for the passive morphosyntax on the finite verb in order to have the first cue disambiguating the non-canonical sentence as such.

The methodology used in Marinis (2007) – to our knowledge the only on-line study to have investigated the off-line and on-line processing of active and passive sentences in L2 children (in this case L1 English children vs. Turkish-speaking L2 English children) – was to measure children's reaction times using a self-paced listening task. One of the novelties of the present study is the use of the *Visual World Paradigm.* The fine-grained sensitivity of this method permits children's linguistic processing to be assessed as it unfolds in real time (Trueswell & Gleitman, 2007),

thus complementing methods that identify difficulties during processing such as the measurement of reaction times.

The aim of the current study was twofold. First, we hoped to shed more light on the child L2 as opposed to the child L1 processing system by providing data from children whose acquisition of the L2 began early, between ages 3 and 4. More precisely, we wished to explore whether the two groups would display quantitative or qualitative differences during processing. Evidence that reliance on the "agent-first strategy" or on a given cue was present in one group but entirely absent in the other would indicate a qualitative difference. On the hand, if the reaction to such a strategy or cue was merely weaker or occurred later in one of the two groups, this would be interpreted as signalling a quantitative difference.

Second, as we found that both L1 and L2 children exhibited good off-line comprehension accuracy scores when interpreting passive sentences, we focused exclusively on those on-line comprehension trials for which both groups provided accurate answers. By doing so, differences in the eye gaze movements between the groups would reflect processing differences between the groups that we would have ignored otherwise. So far most of the studies on child processing combining off-line with on-line tasks have included all trials in the analysis, that is even those with incorrect accuracy scores. They have found that in their on-line processing children reveal a better knowledge of the relevant cues than what their off-line scores would seem to suggest (Adani & Fritzsche, 2015; Huang et al., 2013; Marinis, 2007). In this study, by contrast, by confining ourselves to correct trials only, we have focused on the question of whether children reveal difficulties in their on-line integration of cues even when they are correct in their off-line interpretation.

The chapter is structured as follows. First, we review studies on L1 and L2 child passive acquisition (both production and comprehension), and then turn to the L1 and L2 processing studies. Next, we describe the design of our study, and then present the results for each of our two groups of subjects. Finally, we discuss these findings and draw some conclusions about the light they shed on the L2 child processing system.

3.2 The acquisition and the processing of passive

We chose to study the comprehension of the passive because in the literature on the acquisition of German it is described as one of the structures that are acquired last by both L1 and L2 children and make their text comprehension more difficult (Rösch, 2011). We used the same *werden*-passive structure of the previous study in which we compared monolingual children and adults.

3.2.1 Acquisition in monolingual children

In child free production, passive sentences can be rarely found. Studies show that until the age of 3 children produce no passives (Mills, 1985) and even if they acquire the passive morphosyntax in the first years of language acquisition (Wittek & Tomasello, 2005), they seem to avoid this structure in primary school age (Grimm, 1975; Mills, 1985; Rickheit, 1975). Even in an elicited task, in which 6- and 7-year-olds were presented with passive-bias questions, they were shown to reply the questions by using mostly active instead of passive sentences (Haberzettl, 1998).

Off-line studies on the comprehension of English and German passives using act-out and sentence-picture matching tasks have shown that children at the earliest stages of linguistic development interpret the sentences predominantly according to a "agent-first strategy" (for German: Aschermann et al., 2004; Dittmar et al., 2014; Grimm, 1975; Mills, 1977; for English: Maratsos, 1974; Stromswold, under review). In a subsequent phase, children are shown to be more sensitive to semantic and pragmatic factors and still overlook the passive morphosyntax (for German: Grimm, 1975; Mills, 1977; Schaner-Wolles, 1989; for English: Turner & Rommetveit, 1967). Some of the abovementioned studies using an act-out task provided evidence that around the age of 5, children start to rely more on their morphosyntactic knowledge than on the "agent-first strategy". Nevertheless, up to age 7, children have still difficulties with reversible passives, because semantic information offers no cue to

interpretation,[16] and they still make frequent use of the "agent-first strategy" to interpret this structure (percentage of correctly interpreted reversible passives at age 5, for German: Aschermann et al., 2004, 88%; Dittmar et al., 2014 82%; Grimm, 1975, 79%; for English: Maratsos, 1974, 81%; Turner & Rommetveit, 1967, 50%; Stromswold, under review, 71%).

3.2.2 Acquisition in second language children

With regard to production, Wegener (1998) found that passive sentences by Turkish-German children between the age of 6 and 8 are rare and not error-free. Most of the errors were due to a lack of knowledge of the auxiliary *werden*, frequently replaced by the verb *sein* 'to be', and an imperfect command of irregular past participles. In elicited production, similarly to the L1 children of Haberzettl, the same Turkish-German L2 children revealed a preference to describe events from an agent perspective when they were shown pictures depicting an action between an agent and a patient and were then asked passive-biasing questions.

During comprehension, L2 children with an age of onset between the age of 3 and 4, show a similar cues´reliance to the L1 children. Like L1 children, L2 children rely most on the "agent-first strategy", then on semantic cues and finally on morphosyntactic cues (Becker, 2006). In a picture-matching task, Becker found that 7-year-old L2 Turkish-German children performed more poorly than monolingual German children, but showed overall the same qualitative pattern. Both groups found reversible passives the most difficult passive type and L2 7-year-olds´performance with this structure was only slightly above chance. Better scores were achieved when the semantic cue of animacy helped to disambiguate passive sentences. The same pattern was observed in a recent study with older L2 children (age 10), who were still affected by the cues of animacy and plausibility (Root, 2014).

In sum, even if studies on L2 production of passives are rare, they show that passive constructions are encountered later in L2 than L1 child production. Both

[16] In irreversible passives, key semantic information can be provided by the animacy of the two NPs, the agent and patient, such that only one of the two NPs can be the agent of the described event (e.g. *The picture was painted by the girl* and **the girl was painted by the picture*) or by the plausibility of the event in implausible passives, so that only one of the two NPs can be the plausible agent of the described event (e.g. *The mum was fed by the baby*).

groups seem to prefer to use simple structures during communication, such as sentences in the canonical word order and avoid more complex and difficult constructions, such as passives. This preference does not come as a surprise, as it can also be found in adult data. Adults do also prefer the use of more linear, canonical structures and not because of a lack of linguistic knowledge like in the children, but in order to save linguistic resources (Ferreira, 2003). In addition, studies investigating children´s off-line comprehension seem to converge on the fact that L1 and L2 children follow the same acquisitional stages as far as the acquisition of non-canonical sentences concern. Differences between the groups are quantitative as the L2 children during primary school were shown to perform overall worse than the L1 children.

3.2.3 Processing in monolingual children

In this section we summarize studies on L1 children that we have already illustrated in section 2.2.2. The reader is thus invited to skip this section if he or she has already read the previous chapter.

This preference for an "agent-first strategy" can also be observed during on-line processing, as shown by two eye-tracking studies, one involving English-speaking children (Stromswold, under review) and the other involving Chinese-speaking children (Huang et al., 2013). Stromswold (under review) monitored the eye gaze of two groups of children (aged 5;2 and 6;2) while they listened to reversible active and passive sentences in English (active *The boy was tickling the girl* and passive *The boy was tickled by the girl*) and simultaneously inspected two pictures. The action expressed (e.g., to tickle) in the sentence was identical in both the target and distractor pictures, as were the protagonists (e.g., boy and girl). The only difference was which of the two protagonists was mapped onto the agent role or patient role. She found that both age groups processed actives on-line, showing a strong reaction to the active cue (the verb suffix *-ing*) and looking at the picture displaying the boy as the agent. On the other hand, upon hearing the passive morphosyntactic cues (the verb suffix *-ed* and the *by-phrase*), neither group showed the sort of robust reaction they had exhibited in response to active sentences. Rather, only after the end of the

sentence did they start to look more at the correct picture (i.e., in which the boy is the patient), before making their final picture selection. However, the study revealed differences in the processing between the 5- and 6-year-olds. The former were shown to make use of the "agent-first strategy" immediately after the first NP, thus assuming that the first NP was the agent, and were often not able to correct this initial interpretation (68% accurate answers for passive). On the other hand, the 6-year-olds showed a very weak 'agent-first strategy' which lasted from the onset of the auxiliary *was* until the offset of the *by*-phrase, yielding a better performance (84% accurate answers for passive). The author interprets this difference in reliance on the "agent-first strategy" as a behaviour aimed at avoiding the high computational costs associated with a later reassignment of thematic roles in cases where subsequent cues conflict with the initial strategy. Nevertheless, neither age group overcame this initial "agent-first strategy" to such an extent that they looked at the target picture more than at the competitor picture during the time of the sentences, making the author conclude that the English passive, unlike the active, is not processed on-line.

Concerning the comparison between off-line and on-line performance, Stromswold's (under review) data on eye gaze during passive sentences, contrary to the expectations (Marinis, 2010), do not demonstrate that children reveal major linguistic knowledge in the on-line than in the off-line task. On the contrary, this study suggests that children in the off-line findings display more knowledge on passives than the one revealed by the eye movements. By contrast, in another study on processing of the passive, Huang et al. (2013) revealed that Chinese 5-year-olds displayed on-line reaction to the passive morphosyntax, whereas their off-line performance was poor. Similar to the English-speaking 5-year-olds, participants in Huang´s study made use of an initial "agent-first strategy". In the study, participants listened either to active or passive sentences in which the first NP, respectively the agent or patient, was followed by either the active (BE) or the passive morphology (BEI) (*Seal BA/BEI it quickly eat*, 'The seal is quickly eating it/The seal is quickly eaten by it'). Combining an on-line with an off-line task, the authors recorded children's and adults' eye movements while they were performing an act-out task in front of three objects (one corresponding to the expressed NP in the sentence, a likely agent and a likely patient). The eye movement recordings revealed that the children

tended to interpret the first NP as agent while the adults did not. The authors argue that children's still developing executive function abilities might prevent them from abandoning one cue in order to react to another, as also shown by a previous study (but not on passives) with Korean 5-year-olds (Choi & Trueswell, 2010). In addition, while adults were off-line significantly above chance in both conditions, children's performance during passives was not different from chance. Interestingly, however, children consistently misunderstood all passives in the second half of the trials, assigning either to the pronoun or to the first NP the thematic role of agent. On the other hand, in the first half they were able to correctly exploit the passive cue BEI (more in the pronoun than in the NP1 condition). This last finding suggests that the 5-year-olds did have knowledge of the passive morphosyntax even if their poor off-line performance does not provide us with the same picture: "One possibility is that children's eye movements and actions are reflecting different underlying processes. Children may be sensitive to correct role assignments in their on-line processing but are unable to recruit this information to plan their actions" (p. 13).

In sum, the two studies we have reviewed here focusing on the English and Chinese passive respectively provide evidence for an initial sentence interpretation using the "agent-first strategy" in all child groups. Interestingly, concerning off-line and on-line performance, the two studies reveal two different pictures. While in Stromswold (under review), English children were more accurate during the off-line task than during the on-line sentence interpretation, revealing a very slight reaction to the passive cues during on-line processing, Huang et al. (2013) documented that despite poor off-line performance, Chinese children made on-line use of the passive cues. The authors suggested that the off-line act-out task itself might have affected the low off-line accuracy scores (see also, Adani & Fritzsche, 2015) together with further factors, such as a lack-of-attention effect.

Against this background, due to the paucity of studies on on-line passive comprehension involving children and to the unclear picture on the relation between off-line and on-line performance, with the current study we provide new data and attempt to contribute to the issue.

3.2.4 Processing in second language children

As mentioned in the introduction, studies on child L2 processing are rare, and the present study is therefore intended to contribute to redressing this paucity of information making it one the first contributions to the topic.

The only study (to our knowledge) to have investigated the processing of passive sentences in L2 children (Marinis, 2007) reveal quantitative rather than qualitative differences between L1 and L2 children. Marinis tested Turkish- English children aged between 6 and 8 (age of onset between 3 and 4) using a self-paced listening task. The children were presented with reversible active and passive sentences similar to the ones in Stromswold's study (active: *I think that the zebra was kissing the camel at the zoo last Monday*; passive: *I think that the camel was kissed by the zebra at the zoo last Monday* so that the first disambiguation point occurred during the lexical verb, namely the suffixes *-ing* for active and *-ed* for passive) and were shown one picture. The picture either matched the action described in the sentence or not. According to the rationale of the experiment, in the visual/linguistic mismatch condition, increased reaction times are expected for the first disambiguating segments, due to the processing costs needed for revising previous opposite role assignments that are based on the interpretation of the visual context alone. The results showed overall longer reaction times for the L2 children compared to the L1 children, but the same pattern of reaction times to the morphosyntactic cues. L1 and L2 children had longer reaction times in the mismatch condition regardless of whether the sentence was active or passive during the first disambiguating *-ing*/*-ed* segment but longer reaction times during passives than actives during the second NP and *by*-phrase. Nevertheless, despite similar reaction time patterns overall, for passive sentences L2 children correctly judged whether the sentence matched the picture less often than the L1 children (correctly matched picture: 62.5% of the trials for the L2 children vs. 82.8% of the trials for the L1 children). The author concludes that despite the fact that the L2 children recognize the cues, they rely more on simple processing heuristics such as the "agent-first strategy" in their final interpretation.

Finally, it is worth noting that the lower off-line performance despite on-line reaction to the active and passive morphosyntax is in line with Huang et al. (2013).

Children have difficulty inhibiting initial wrong commitments then retaining the new interpretation in order to use it in the off-line task. Since the study tested only one age group, the question remains as to whether older English-learning Turkish children would still reveal poor off-line data and overall longer reaction times than the English age-matched control group.

Hence, it seems that further studies investigating child L2 sentence processing and combining off-line and on-line methods are needed to obtain more detailed data on children's overall comprehension. In this way, we can determine whether the strategies used by L2 children during processing resemble those exploited by L1 children and how the groups differ with respect to their off-line/on-line performance. To our knowledge, no studies with this purpose involving German are yet available.

3.3 Study 2

3.3.1 Overview and research questions

This study focuses on the German *werden*-passive, which is the most frequent passive construction in both written (Brinker, 1971) and spoken German (Eisenberg, 2013). For the current study, we chose to use in our experimental materials examples of the *werden*-passive in the past tense. This was because the present tense form can also be used as part of the future tense construction (when it is followed by an infinitive), leading to potential ambiguity between a future and a passive reading (Abbot-Smith & Behrens, 2006; Knoeferle et al., 2005). By contrast, the past form *wurden* cannot indicate a future action. Nevertheless, *wurden* is not immune to ambiguous reading since it can also be used as a copula verb, as in *Der Opa wurde taub*, 'The grandpa became deaf'. We thus compared past tense passive sentences to active sentences in the present perfect, which in German also refers to the past. Both constructions are analytic constructions with the auxiliary in second position (*wurde* indicating the passive or *hat* indicating the present perfect) and the non-finite past participle appearing sentence-finally (e.g., *Der Opa hat die Frau geküsst* 'The grandpa kissed the woman' or *Der Opa wurde von der Frau geküsst* 'The grandpa was kissed by the woman'.

In the present study, we conducted two experiments, the first with L1 and L2 10-year-olds (experiment 2.1 in the dissertation) and the second with L1 and L2 7-year-olds (experiment 2.2 in the dissertation). In both experiments we will undertake to answer two research questions.

(1) How do L1 and L2 10-year-olds and 7-year-olds perform in the off-line task?

(2) If children's off-line performance is high, are there between-group differences during their on-line processing when they accurately respond to the off-line task in terms of their use of the "agent-first strategy" and reaction to the active and passive morphosyntax?

3.3.2 Experiment 2.1: study with L1 and L2 10 year-olds

3.3.2.1 Participants

Twenty-five 10-year-old monolingual German-speaking children (13 female and 12 male) and twenty-four 10-year-old Turkish-speaking L2 German children (10 female and 14 male; age range = 9-11; mean age 10.1[17]) participated in the study. The participants were recruited from primary schools and after-school care centres in Osnabrück, Germany (a midsized German city). At the time of experiment, they were attending the fourth grade of the German primary school system. Children were tested in a university laboratory and afterwards received a child-friendly certificate as a reward of their participation. Parental consent was obtained prior to the experiment. All participants had normal or corrected-to-normal vision, and were naïve with respect to the purpose of the experiment. The Turkish-speaking L2 German children had first been exposed to German around the age of 3 or 4 upon entrance to Kindergarten and presented different habits as regards the language they spoke at home, often depending the interlocutor. The most frequent pattern emerging from interviews conducted with parents revealed a preference for speaking German with siblings and Turkish with parents**.** Appendix A.2 provides detailed information about the languages spoken by the Turkish children within their family and the age at which they began to speak the L2.

3.3.2.2 Proficiency of the 10-year-olds

To determine their general proficiency in German at the time of testing, all the children first completed a version of a C-Test, designed specifically to test the proficiency of children attending the fourth year of the German primary school system (Baur & Spettman, 2009). This test consisted of three short written texts (constructed by Grießhaber) in which 18-20 words had been truncated by 1-9 letters such that the word was missing one or two of its final morphemes (see Appendix C.1). The participants must then add the missing information to make the words grammatical in that context. The L1 German control group of children achieved a

[17] For the 10-year-olds, we do not provide standard deviation since we did not collect information on their birthday and thus only have their age expressed in years.

mean grammatical accuracy rate of 86%, while the mean accuracy for the L2 German group was 68%. An independent samples t-test indicated that this difference was significant in both participant and item analysis ($t(47) = 6.66$, $p < .0001$). The results corroborate previous findings on overall poorer grammatical knowledge in children with German as L2 in comparison to L1 children (see Ahrenholz, 2012 for an overview of this issue). With this baseline information available, we then proceeded to carry out the experiment proper.

3.3.2.3 Materials

The materials were identical to those described in chapter 2.

3.3.2.4 Procedure

The procedure was identical to those described in chapter 2.

3.3.2.5 Coding

For the analysis of the eye-tracking data, the experimental sentences were divided into 4 main time segments. The reference point for the start of the analysis was the onset of the sound file including the first NP, in other words, before there was sufficient information to allow any disambiguation between an active or passive interpretation (time segment 1). The subsequent time segments were determined on the basis of the onset of the critical morphosyntactic cues, namely the two auxiliaries *hat* and *wurde* (time segment 2), the second disambiguating cues, the second NP (for actives) or the *by*-phrase (for passives) (time segment 3) and the past participles (time segment 4).

Because the programming and execution of a saccade takes place 200 ms after the reception of the associated verbal input (Matin et al., 1993; Rayner, 1998) we also ran statistical analyses for the time for the first 0-200 ms of time segments 2 and 3 in order to measure spill-over effects from the previous time segment. By doing so, we had a more precise view of the time course of the gaze fixations, given that many processes were observed to take place in these segments. Moreover, due to its relatively long duration, time segment 3, which included the second disambiguating morphosyntactic cues (2nd NP for actives and *by*-phrase for passives), was further

split into two parts so that in total it was made up of three parts (0-200, 200-700 ms and 700-1200 ms), in order to permit a more precise analysis.

Segment onsets were calculated on a sentence-by-sentence basis. The length of each time segment (Table 3) was established taking into consideration the average, earliest and latest onset of the subsequent cues in the next time segment, in order to avoid including in the analysis processing triggered by other cues (see chapter 2.3.5 for a description of how the length of the segments were calculated and how the onsets of the subsequent cues were taken into account).

	Time Segment 1	**Time Segment 2**			**Time Segment 3**		**Time Segment 4**
	Sentence Onset 200+500ms (1stNP)	**Onset AUX 0-200ms**	**200-500ms**	**500-900ms**	**Onset 2nd NP/by-phrase 200-700ms**	**700-1200ms**	**Onset PPART 200-500ms**
ACTIVE	Der Opa	hat am Abend			die Oma ganz kurz		gekitzelt
PASSIVE	Der Opa	wurde am Abend			von der Oma ganz kurz		gekitzelt

Table 3: Time segments (Experiment 2.1,2.2 of Study 2), selected on the basis of cue onset

Both accuracy and eye movement data were analysed with logistic mixed effect models using R (R development Core Team, 2012) and the R packages *lme 4* (Bates, Mächler, Bolker, & Walker, 2015) and *languageR* (Baayen, 2011).

In the results section, we will report the results for each time segment. Effects of interest for our research questions are main effects of Image or interactions between Image and Sentence Type, Image and Language Group, or a three-way-interaction between Image, Language Group and Sentence Type. A main effect of Image means that the subject's gaze was fixed on congruent and incongruent images to significantly different degrees. An interaction of Image and Sentence Type would indicate that the preference for the congruent over the incongruent image (or vice versa) is not the same in the two experimental conditions or also a difference robustness of the interaction between the groups. Finally, interactions with Language Group indicate that these effects differed between language groups.[18] All effects for each time segment are reported in Appendix D.2.

[18] We will not discuss main effects of Language, Sentence Type or interactions of Sentence Type and Language, as we have no hypotheses for these factors.

Possible eye movement patterns

We expected the same patterns as in the previous study (see 2.3.5 for a description).

3.3.2.6 Results

3.3.2.6.1 Accuracy

For the accuracy data, the dependent variable was whether participants chose the target or the competitor picture. The 10-year-old L1 children and L2 children did not show apparent differences in selecting the target picture during actives and passives, with a mean accuracy rate for the L1[19] and L2 children[20] respectively of 93.5% and 94.3% for active and 94% and 93.2% for passive. We analysed these results using a model containing Language Group (German as L1, German as L2) and Sentence Type (active, passive) as well as their interaction and participants and items as random factors and including individual slopes for Language Group and Sentence Type (lmer and binomial family in R) (Baayen, 2008; Barr et al., 2013; Jaeger, 2008).

We found no significant interaction (estimate = -1.5450, std. = 0.9982, z = -1.548, p = 0.122) and no main effects (Language Group: estimate = 0.5485, std. = 0.6715, z = 0.817, p = 0.414; Sentence Type: estimate = 0.6856 , std. = 0.7726, z = 0.887, p = 0.375). This indicates that accuracy scores were similar between the two groups in both conditions.

[19] Five trials in total (2.5%) were excluded from the analysis of the L1 children. One trial during active (0.5%) provided no answer, and four trials (2%), one for active and three for passive, were marked as skipped trials because no eye gaze was detected, probably because participants pressed the key too long.

[20] Four trials in total (2%) were excluded from the analysis of the L2 children. One trial during passive (0.5%) elicited no answer, and two trials during active (1%) were marked as skipped trials because no eye gazed was detected. In one additional trial during active (0.5%) a computer failure occurred.

3.3.2.6.2 Eye movement data

In view of the high scores achieved by both groups in both conditions, we chose to analyse the eye gaze data including only those trials for which participants accurately selected the correct picture. In this way, we would be able to investigate whether, despite their high off-line performance, subjects experienced difficulties in their on-line performance, as previously shown by Stromswold (under review). For the eye movement data, the dependent variable was the sum of gaze fixations on the target or competitor picture. Cases in which participants did not correctly interpret the sentences (incongruent trials) were removed from the analysis. Trials with recording problems (e.g., track loss, trials skipped) were also excluded from the analysis. We measured gaze fixations on the target or competitor picture at every 20 ms (Järvikivi et al., 2013). The sum of these gaze fixations was then computed for each time segment.

For all data sets, we first computed a full model including a three-way interaction, with Language Group (German as L1, German as L2), Image (congruent, incongruent) and Sentence Type (active, passive) as fixed factors, and participants and items as random effects, including random slopes by participant and item for all fixed factors and their interactions (Baayen, 2008; Barr et al., 2013; Jaeger, 2008). In cases where the full model did not converge, interaction terms were removed from the random slopes of the model. The first converging model was defined as the maximum model, against which all simpler models were compared by log-likelihood ratio test with the anova function in R (see, e.g., Barr et al., 2013). Model comparisons ensured that the model containing the interactions was a significantly better fit to the data than a simpler model with just the three main effects. In all but one analysis (time segment 1; analysis of the 7-year-olds), the full model with all fixed effects and their interactions proved to be better than simpler models.

Figure 7 is a graph of mean proportion of participant gaze fixations on the target picture out of all fixations occurring during the duration of each experimental sentence, separated by age group and sentence type. Figure 7 clearly shows that inspections of the target picture from the onset of the sentences did not remain at chance level at any time while participants were listening to the sentences. Participant

gaze fixations fluctuated between the target and competitor picture, reflecting their attempts to assign thematic roles on-line.

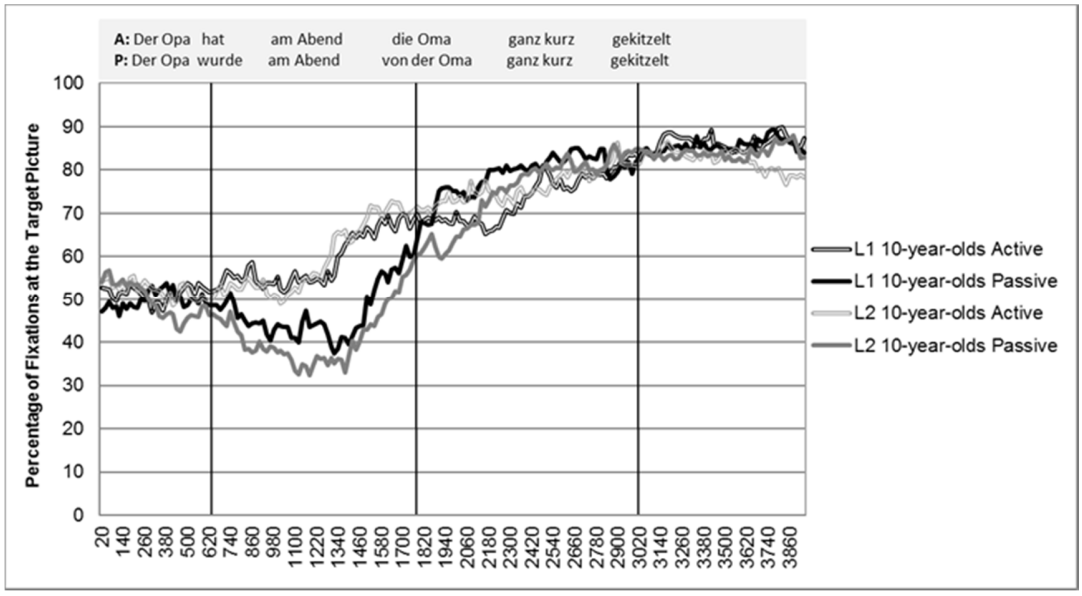


Figure 7: Plot of 10-year-old language-group averages for gaze fixations from start to finish of trial (active and passive sentences, correct trials only), showing percentages of fixations directed at the target picture

Time segment 1: nominative NPs (der Opa/die Oma)

Figure 8: Gaze fixation during Time Segment 1: plot of 10-year-old language-group averages for gaze fixations from start of trial (active and passive sentences, correct trials only) until 550 ms, showing percentages of fixations directed at the target picture

The first time segment includes the time when participants heard the first NP of active and passive sentences. We did not find any statistically significant effects.

Discussion: time segment 1

The lack of significant effects indicates that both language groups did not assign any thematic roles when hearing the first NP.

Time segment 2: auxiliaries (active, hat; passive, wurde)

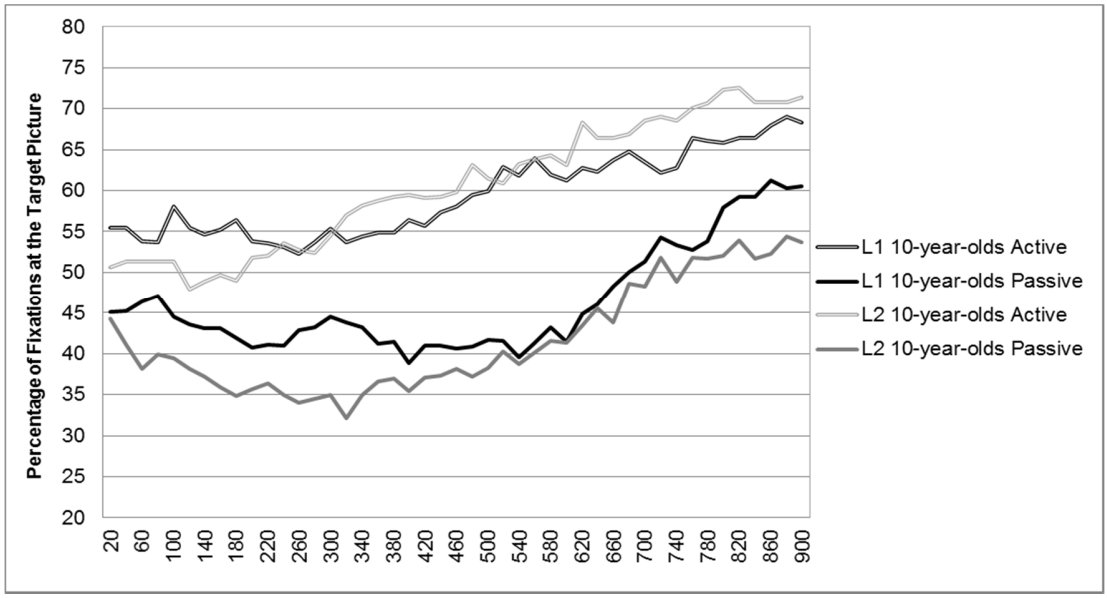


Figure 9: Gaze fixation during time segment 2: plot of 10-year-old language-group averages for gaze fixations from the onset of auxiliaries until 900 ms (active and passive sentences, correct trials only), showing percentages of fixations directed at the target picture

0-200

During the first part of time segment 2, which includes the onset of the disambiguating cues *hat* or *wurde*, we assume that the effects detected are not triggered by the cues as 200 ms is roughly the time necessary to account for the programming of a saccadic eye movement (Matin et al., 1993; Rayner, 1998). For this reason, the effects must be interpreted as spillover effects from the preceding time segment. We found an interaction between Image and Sentence Type with no additional main effect of Image. There was no three-way interaction with the factor Language Group, indicating that the two-way interaction was present in both language groups to a similar extent. Inspections of the graph suggest that the

significant interaction is caused by a higher number of gaze fixations on the congruent picture during actives and on the incongruent picture during passives. Separate analysis of the main effect of Image by Sentence Type revealed a significant main effect of Image during actives and passives.

200-900

At this time point the effects must be considered the results of the auxiliaries. We found a significant three-way interaction among Language Group, Image and Sentence Type. Separate analysis by language group revealed for the L1 children a significant interaction between Image and Sentence Type with a main effect of Image. Further separate analysis by Sentence Type showed a main effect of Image during actives and passives. These two effects – the interaction and the main effect of Image in the separate analysis of the active and passive trials – indicate that there was an effect in both cases. Moreover, the fact that we found besides the interaction a main effect of Image suggests that the tendency described for the interaction was not balanced in the two conditions. As a matter of fact, we see that at the end of the time segment, the eye gazes at the incongruent picture during passives are not maintained and/or target fixations increase.

In the analysis of the L2 children, there was a significant interaction between Image and Sentence Type as well, with a main effect of Image. Separate analysis of the effect of Image for the two sentence types revealed a main effect of Image for both actives and passives. The presence of a main effect of Image in both Sentence Type conditions suggests that the tendency of the L2 children to prefer the congruent picture during actives and the incongruent during passives was present in both conditions. Like in the analysis for the L1 children, the main effect next to the interaction suggests that the tendency described for the interaction was not identical in the two conditions and that gazes at the incorrect picture in the passive condition are not maintained until the end of the time window.

Discussion: time segment 2

During the first part of the time segment (0-200 ms), the significant interaction between Image and Sentence Type in both the L1 and the L2 children indicates that

both groups started to make use of an "agent-first strategy". Because of the time required for programming a gaze fixation, we were able to show that this strategy is a delayed result of the first NP (including any cue for disambiguation) and not of the disambiguating auxiliaries. Moreover, the absence of any significant three-way-interaction with the factor Language Group indicates no significant differences between the two groups concerning the assignment of the agentive role to the first NP.

During the second part of the time segment (200-900 ms), we found a significant three-way interaction. In analyses separated by Language Group, we found in both groups a significant interaction between Image and Sentence Type and a main effect of Image. Separate analysis of the interaction revealed a main effect of Image during actives in both groups (which is absent in the preceding 0-200 ms), suggesting that the preference to look at the congruent picture when hearing an active sentence was present in both groups. The main effect of Image coupled with the interaction and close inspection of the graph suggest that both the L1 and L2 children had a slight preference for looking more at the target picture during actives than looking at the competitor during passives. We can see that gaze fixations at the target picture during passives diminish during the course of the time segment, while this is not true for the active condition. Moreover, close inspection of Figure 9, shows that they started to increase target fixations during actives at the same time point and to the same degree in both groups. During passives, we found the same main effect of Image in both groups, indicating the presence of the same tendency to look at the incongruent picture during passives. The fact that we found a significant three-way interaction despite the same significant effects in the separate analysis suggests that the strength of the effects might be responsible for the three-way interaction. Inspection of the graph shows that in both conditions L2 children revealed either more target fixations during actives or fixations at the competitor picture during passives. Moreover, even if statistically the main effect of Image reached significance in both conditions and in both groups, descriptively the "agent-first strategy" is generally stronger for passives than for actives. This pattern comes as a surprise, as we would have expected the use of an "agent-first strategy" to have the same intensity in both conditions, that is, showing a symmetrical mirror image, meaning

the same number of fixations on the congruent picture during active and on the incongruent picture during passives. Note that the "agent-first strategy" is in coalition with the active auxiliary *hat* and in competition with the passive cue *wurde*. Eye gaze data show instead that L1 and L2 children had a pronounced tendency to inspect the competitor picture more during passive trials than to inspect the target picture during active trials. One possible explanation for this pattern could be that children were less challenged during the processing of active sentences, and that there were therefore more random fixations in the active than in the passive condition.

At the end, both groups suppressed the "agent-first strategy" and started to reanalyse passive sentences by looking more at the congruent picture in which the first NP is the patient at the same time point in the sentence, that is, at the end of the time segment. Statistically, this is reflected in the presence of the main effect of Image alongside the interaction that we found in both group analyses, indicating that the tendency to look more at the target picture during actives than at the incongruent picture during passives was differently weighted in the two conditions.

Time segment 3: active, accusative NP ; passive, von-phrase

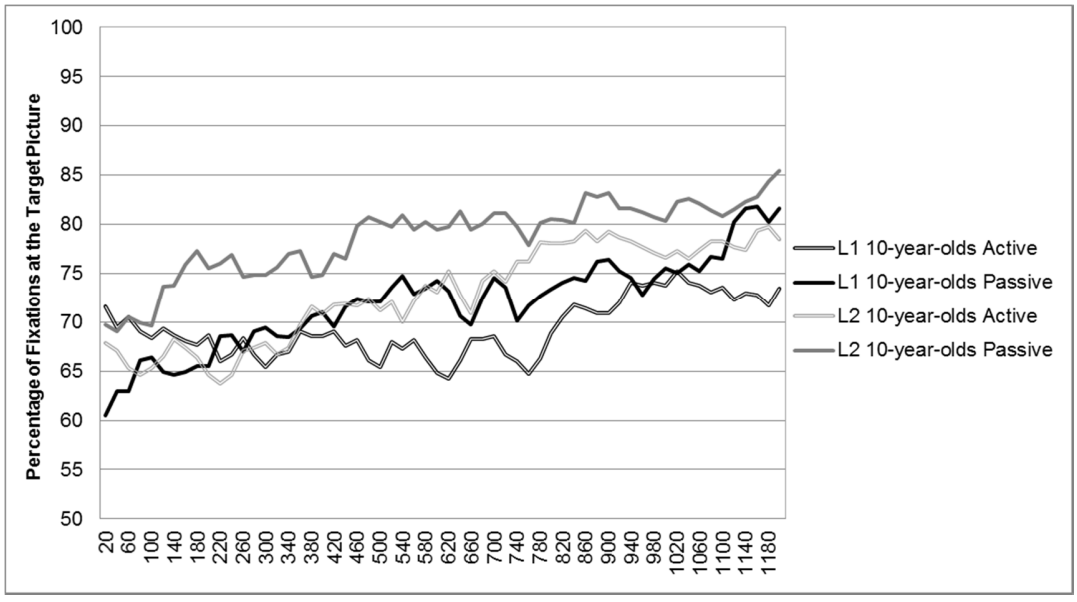


Figure 10: Gaze fixation during time segment 3: plot of 10-year-old, language-group averages for gaze fixations from the onset of the second NP or by-phrase until 1200 ms (active and passive sentences, respectively, correct trials only), showing percentages of fixations directed at the target picture

0-200

Similarly to the previous time segment, the effects during the first part of time segment 3 cannot be attributed to the second morphosyntactic disambiguating cue, which is the second NP in the case of actives and the *by*-phrase in the case of passives. We found a main effect of Image with no additional significant effects. L1 and L2 children's target fixations were directed more at the congruent picture during both active and passive trials.

200-700

In the second part of the time segment, after the processing of the second NP for actives and the *by*-phrase for passives, we found again a three-way interaction among Language Group, Image and Sentence Type. Separate analysis for the interaction by Language Group revealed for the L1 children a significant interaction between Image and Sentence Type. Separate analyses of the factor Image by Sentence Type showed a main effect of Image for both actives and passives. The interaction is due to the fact that, just as they did in the initial part of the time segment, the L1 children kept looking more at the congruent picture during passives than during actives. For the L2 children, the interaction did not reach significance and there was only a main effect of Image. This might indicate that the second morphosyntactic cues played the role of confirming cues and led to more gazes being directed at the correct picture during passives.

700-1200

During the third part of the time segment, the three-way interaction did not reach significance and we found a two-way interaction between Image and Sentence Type. Separate analysis of the interaction by Sentence Type revealed a main effect of Image during both active and passive trials. The significant interaction reflects a higher number of gazes directed at the target picture during passives than during actives for both language groups.

Discussion: Time segment 3

In the third time segment, before the programming and execution of eye movements in response to the second morphosyntactic disambiguating cues, that is, the second NP for the active condition and the *by*-phrase for the passive condition, both groups were already looking predominantly at the congruent picture in both conditions. The three-way interaction might indicate that whereas the L1 children might not have felt challenged by the active sentences and thus showed fewer gazes at the target picture, the L2 children still found passive sentences more difficult than actives and directed their gaze at the correct picture more often when hearing passive sentences. For the L2 children, the active and passive cues – and especially the *by*-phrase – seem to have played a robust confirming role, as indicated by the lack of interaction in the second part of the time segment and the presence of a main effect of Image only. Descriptively, this is supported by the rapid increase in target gazes. In the third part of the time segment, no significant differences are found between the two groups, which both probably shows a lack of challenge during active trials.

Time segment 4: past participles

Figure 11:Gaze fixation during time segment 4: plot of 10-year-old language-group averages for gaze fixations from the onset of the past participle until 500 ms (active and passive sentences, correct trials only), showing percentages of fixations directed at the target picture

We found a main effect of Image only after the onset of the past participles.

Discussion: Time segment 4

Both groups looked more at the target pictures in both conditions and did not reveal any differences in the processing of actives and passives.

Summary

Both groups made the same initial use of the "agent-first strategy" almost at the end of the first NP. With the onset of the auxiliaries they kept making use of it, thus being on the right track during actives and on the wrong during passives. This preference was slightly more pronounced for the L2 than the L1 children. Nevertheless, the revision process started at the same time in both groups, so that the two groups did not reveal difficulties in abandoning the "agent-first strategy" and/or in reacting to the passive morphosyntax. With the onset of the second disambiguating cues, both groups were above chance in both conditions. The remaining differences may be due to the less challenge posed by the active sentences for the L1 children.

3.3.3 Experiment 2.2: study with L1 and L2 7 year-olds

3.3.3.1 Participants

Participants were twenty-four 7-year-old L1 German children (17 female and 7 male; age range = 6,6-7,8; mean age 7.1 years; SD = .4775) and seventeen 7-year-old Turkish-speaking L2 German children (7 female and 10 male; age range = 6,5-7,8; mean age 7,2; SD = .5587). At the time of data collection, they were attending the end of the first year of primary school in Germany. The 7-year-olds were similar to the 10-year-olds described above as regards the onset of L2 exposure and language habits at home. Detailed biographical information is provided in Appendix A.2. Participants were recruited and tested in schools in Osnabrück and Berlin. All children had normal or corrected-to-normal vision and were naïve as regards the purpose of the experiment. For their participation in the study, they were each given a child-friendly certificate of recognition.

3.3.3.2 Proficiency of the L1 and L2 7-year-olds

To assess the 7-year-olds' proficiency in German, we used an *Elicited Imitation Test* (henceforth EI task; see Erlam, 2006, for a thorough explanation of the method) whereby participants hear a series of sentences – some of which are ungrammatical – and are asked to repeat them as exactly as possible. Either failure to accurately imitate grammatically correct sentences or failure to normalize grammatically incorrect sentences is taken to reflect language preferences, since participants have been observed to change items in ways that closely resemble their own spontaneous use (Brown, 1973; Schimke, 2011). The EI task was designed to give an overview of participants' grammatical knowledge of four linguistic phenomena, two at the word-level (nominal case-marking and gender/adjective inflection) and two at the phrase-level (subject-verb agreement and verb inversion). A list of 24 items (including 7-9 syllables and words appropriate for the age investigated) was constructed, half of them consisting of grammatically correct items and the other half of grammatically incorrect items. Table 4 provides an example of one grammatically correct and one

grammatically incorrect item per linguistic phenomenon. The complete list with all items is provided in Appendix C.2.

	Grammatical Item	*** Ungrammatical Item**
Nominal Case Marking	*Der Polizist fährt* ***mit dem Auto*** The policeman drives with (+ DAT) the car	** Die Tante spielt* ***mit die Tiere (mit den Tieren)*** The aunt plays with the animals
Gender Inflection on Adjective	*Der Bäcker trägt* ***ein buntes T-Shirt*** The baker wears a colourful T-shirt (ADJ. STRONG INFL.)	** Der Prinz hat* ***eines schönen Schloss (ein schönes Schloss)*** The prince has a beatiful castle
Subject-Verb Agreement	***Der Mann fährt*** *zum Bauernhof* The man drives to the farm (VERB: 3rd P.SING.)	**** Der schwarze Hund bellen*** *laut* ***(bellet*** *oder* ***der Hund)*** The black dog barks loud
Subject-Verb Inversion	*Im blauen Meer* ***schwimmt*** *der Opa* In the blue sea swims the grandpa (V2)	** Im grünen Wald der Vater* ***jagt (jagt*** *der Vater****)*** In the green wood the father hunts

Table 4: Overview of one grammatically correct and one incorrect item per linguistic phenomenon

In order to prevent participants from repeating verbatim the items by retaining many details of form, we introduced a time interval between the end of the target sentence and the start of the elicited response, so that participants were forced to reconstruct the items by using the grammatical knowledge at their disposal (McDade, Simpson, & Lamb, 1982; Sachs, 1967). When participants repeated an ungrammatical item incorrectly, they were given a score of "0". When participants repeated correctly a grammatical item or an ungrammatical item (thus normalizing it) they were given a score of "1". Finally, if they inaccurately repeated a grammatical item, they were given a score of "-1". For each group, we converted the absolute average value into a percentage. The L1 children scored 99% for accurately repeating correct items and 74% for normalizing incorrect items while the analogous scores for the L2 children were 84% and 40%.[21] Two independent sample t-tests were executed, one for the condition in which participants were given grammatically correct items and one for the condition in which participants were given grammatically incorrect items. In the first test, the differences between the L1 and L2 children were significant in both

[21] Percentage divided per phenomenon: nominal case-marking, subject-verb agreement, adjective inflection and inversion. Corrected repetitions of correct items: L1 children, 99%, 100%, 97% and 100%; L2 children, 73%, 96%, 69% and 98%. Corrected repetitions of incorrect items: L1 children, 75%, 74%, 76% and 72%; L2 children, 33%, 49%, 33% and 45%.

participant and item analyses ($t1(39) = 5.082$, $p < .05$; $t2(22) = 3.201$, $p = .004$). In the second test, the differences were significant as well in both analyses ($t1(39) = -3.783$, $p = .001$; $t2(23) = -6.024$, $p < .05$). These results together suggest that overall grammatical competence in German was lower in the L2 children than in the L1 children.

3.3.3.3 Materials

The same materials as in Experiment 1 (chapter 2) were used except that in some cases the visual stimuli (i.e., the congruent/incongruent images) were shown as WMV files with a resolution of 313 x 192 pixels and created using Windows Movie Maker 2.6.[22]

3.3.3.4 Procedure

Participants were tested individually in a quiet classroom in their respective primary schools under good lighting conditions. They heard the audio stimuli while they observed the visual stimuli on an external 21-inch Samsung monitor at a resolution of 1920 x 1080. Gaze data was recorded using a Tobii X1 Light Eye-tracker and logged Tobii Studio software running on a DELL netbook positioned in front of the experimenter. Subjects were seated about 50 cm from the eye-tracker screen and the experimenter sat on their right. The movements of both eyes of the subject were recorded. Before the start of the experiment, participants were instructed to listen to the sentences until the end and then to select the picture which matched the given sentence by pressing one of two buttons on a keyboard (*Visual Word Paradigm*, Tanenhaus et al., 1995). This provided us with the accuracy results. Before the start of the experiment, participants were automatically calibrated using a nine-point gaze fixation pattern and, when requested by the system, a re-calibration was carried out between trials. After every experimental video, participants were shown a 'reward' picture, and were asked to fix their gaze on a dot on the screen. Like with the 10-

[22] Due to programming reasons, the stimuli consisted of separate pictures and audio files for the Eyelink I, and video clips for the Tobii X1 Light Eye-tracker. Nevertheless, from the perspective of the participants, the result was identical.

year-olds, there was a preview time of 2500 ms. The experiment lasted approximately 20 minutes per subject.

3.3.3.5 Coding

The same coding method as that applied in Experiment 2.1 (present chapter) was used.

3.3.3.6 Results

3.3.3.6.1 Accuracy

There were differences in response accuracy between L1 and L2 children in their comprehension of active and passive sentences. For active, the mean accuracy rate was 94.2% for the L1 children[23] and 97.8% for the L2 children.[24] The opposite pattern emerged in the passive condition, with the L1 children producing an average correct picture-match score of 93.2% compared to the L2 children's 80.1%. Like in the previous study with the 10-year-olds, the children's accuracy data were analysed using a generalized linear mixed-effect model (Baayen, 2008) with Language Group and Sentence Type as well as their interaction as fixed effects and participants and items as random factors including individual slopes for Language Group and Sentence Type. We did not find any significant interaction (estimate = -18.0995, std. = 13.1281, z = -1.379, p = 0.1680) or main effects (Sentence Type: estimate = -0.9773, std. = 0.5495, z = -1.779, p = 0.0753; Language Group: estimate = 17.0817, std. = 13.1169, z = 1.302, p = 0.1928). There was thus no significant difference in the performance on active and passive sentence comprehension between L1 and L2 children.

[23] Sixteen trials in total (8.7%) were excluded from the analyses of the L1 children. 14 trials elicited no answer (7.6%), seven in the active and seven in the passive condition, and two trials during actives were classified as "trial skipped" (1.1%), because no eye gaze was detected, probably because participants pressed the key too long, and the program moved on to the next trial.

[24] Nine trials in total (6.7%) were excluded from the analysis of the L2 children. Four elicited no answer (3%), two in the active and two in the passive condition and five trials were classified as "trial skipped" (3.7%), two during actives and three during passives.

3.3.3.6.2 Eye movement data

The same eye movement analysis described above for Experiment 2.1 was conducted for the 7-year-olds. Like in the analysis of the 10-year-olds we analyzed only correct trials.

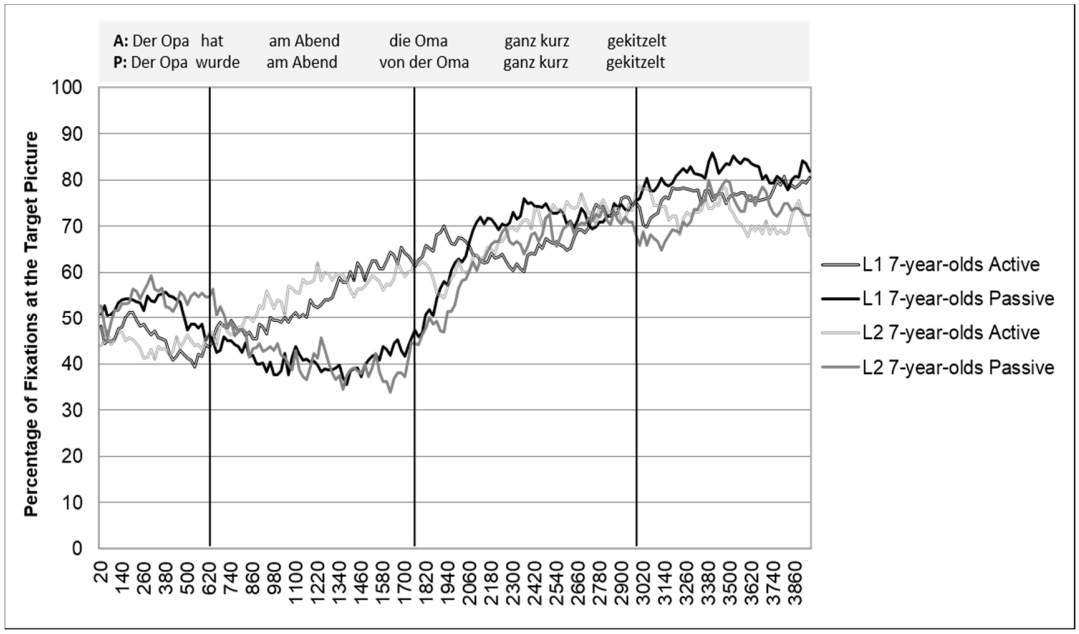


Figure 12: Plot of 7-year-old language-group averages for gaze fixations from start to finish of trial (active and passive sentences, correct trials only), showing percentages of fixations directed at the target picture

Figure 12 is a graph showing the percentage of gaze fixations on the target picture out of all fixations, broken down by Language Group and type of utterance. Similarly to what we saw in the graph for the 10-year-olds (see Figure 7), target gazes fluctuate during both active and passive trials, indicating that the 7-year-olds are also prone to assign thematic roles on the fly.

Time segment 1: nominative NPs (der Opa/die Oma)

Figure 13: Gaze fixation during Time Segment time segment 1: plot of 7-year-old, language-group averages for gaze fixations from start of trial (active and passive sentences, correct trials only) until 550 ms, showing percentages of fixations directed at the target picture

During the time in which participants heard the first NP without any cue to whether the ensuing sentence would be active or passive, we found a two-way interaction between Image and Sentence Type. Separate analysis of the interaction by Sentence Type showed no main effect of Image for actives and passives, indicating the weak robustness of the strategy.

Discussion: Time segment 1

Both L1 and L2 children seem to have adopted a "patient-first strategy", as eye gazes were directed predominantly at the picture in which the first NP heard was not the agent of the action but rather the patient, which was the target picture for passive sentences. Hence, it seems that they perceived the person who underwent the action as more salient then the one who carried out the action.

Time segment 2: auxiliaries (active, hat; passive, wurde)

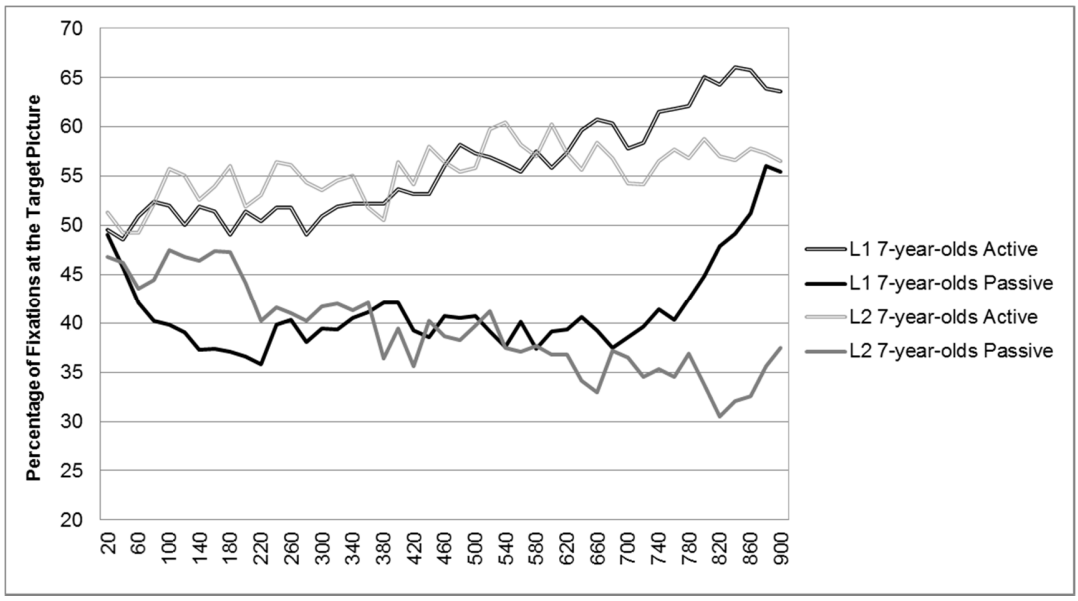


Figure 14: Gaze fixation during time segment 2: plot of 7-year-old, language-group averages for gaze fixations from the onset of auxiliaries until 900 ms (active and passive sentences, correct trials only), showing percentages of fixations directed at the target picture

0-200

Similarly to the precedent experiment, we assume that any effects in this first part of the time segment are not the product of the auxiliaries, *hat* or *wurde*, but spillover effects from the previous ambiguous time segment. We found a three-way interaction among Image, Language Group and Sentence Type with no additional main effect of Image. Separate analysis of the interaction per Language Groups revealed for the L1 children a two-way interaction between Image and Sentence Type, due to more gazes directed at the target picture during active than passive trials. Separate analyses of the interaction showed for the L1 children a main effect of Image during passive trials only. Analysis of the L2 children showed no significant effects.

200-900

In this part the effects may be interpreted as a reaction to the auxiliaries. We found a significant three-way interaction among Image, Language Group and Sentence Type with a main effect of Image. Separate analyses of the interaction per Language Group revealed for the L1 children a significant two-way interaction between Image and Sentence Type and a main effect of Image. The interaction is due to the higher

number of gazes at the target picture during active than passive trials, while the main effect of Image indicates that this effect has an overall effect, showing that the preference described above for the interaction might be unbalanced between the two conditions. Further separate analyses by Sentence Type showed a significant main effect of Image during both active and passive trials. For the L2 children we found a significant two-way interaction as well, with no additional main effect of Image. Separate analysis of the effect of Image for the two conditions revealed no significant effects.

Discussion: time segment 2

The significant interaction between Image and Sentence Type for the L1 group indicates that they started to process the sentences by assigning the role of agent to the first NP. On the other hand, analysis of the L2 children's gaze fixations showed no interaction, suggesting the use of no strategy in particular. A similar pattern is encountered in the second part of the time segment, in which the effects are determined by the auxiliaries. For the L1 children the main effects of Image during passive and active trials, suggest again the robustness of the "agent-first strategy". Nevertheless, descriptively, L1 children's fixations at the end of the time segment started to increase, indicating the first attempt to revise their interpretation.

For the L2 children, the absence of main effects of Image in the separate analysis of the interaction might be due to a smaller number of data points and/or the greater variability within the group since, descriptively, target fixations in the two conditions do not seem to differ greatly from those of the L1 children. In addition, similarly to what we saw in our previous analysis of the 10-year-olds, target fixations of the L2 children did not exhibit mirror symmetry. Target fixations were lower than 40% during passives, whereas during actives they did not exceed the 60% line for the entirety of the time segment.

Again, this pattern comes as a surprise, as we could have expected that, since the L2 children show such a strong preference for an "agent-first strategy" when interpreting passives, we would also find it during actives. The explanation might be the same as for the 10-year-olds, that is, 7-year-old L2 children did not find active

sentences challenging enough to look substantially more at the target than competitor picture.

At the end of the time segment, L2 children showed an attempt, even if minimal, to give up the "agent-first strategy". However, differently from the L1 children, target gazes for passives were below the 40% line until the end of the time segment, indicating that the "agent-first strategy" was not completely overcome until the end of the time segment.

Time segment 3: active, accusative NP ; passive, von-phrase

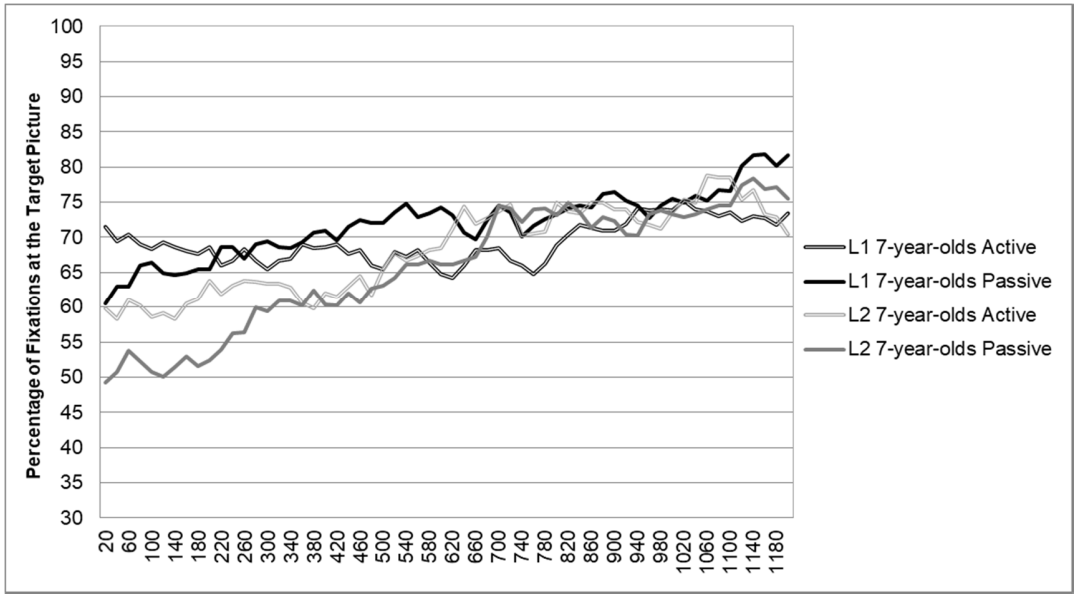


Figure 15: Gaze fixation during time segment 3: plot of 7-year-old, language-group averages for gaze fixations from the onset of the second NP or by-phrase until 1200 ms (active and passive sentences, respectively, correct trials only), showing percentages of fixations directed at the target picture

0-200

In the first part of the third time segment, in which we assume that the second morphosyntactic cues have no effects, we found a two-way interaction between Image and Sentence Type. Separate analysis by Sentence Type revealed a main effect of Image during both active and passive trials. Inspection of the graph shows more target fixations during actives and more gazes directed at the competitor picture during passives, regardless of language group.

200-700

In the second part we found a three-way interaction among Image, Language Group and Sentence Type and a main effect of Image. Separate analyses by Language Group revealed for the L1 children a two-way interaction between Image and Sentence Type with a main effect of Image. Further analyses of the interaction showed a main effect of Image during both active and passive trials. The interaction is due to the fact that even though the target picture was looked at in the great majority of the cases, as also demonstrated by the main effect of Image, the passive sentences led to more gazes being directed at the correct picture than did the actives. Analysis of the L2 children data showed no significant interaction and only a main effect of Image, with a higher degree of gaze fixations at the target picture than at the competitor in both conditions.

700-1200

The same effects for both groups were found in the third part of the time segment.

Discussion: time segment 3

In the initial part of the time segment the two-way interaction between Image and Sentence Type indicates that both L1 and L2 children were looking at the target picture relatively more during actives than during passives. However, target fixations were in both conditions above the 50% line, so that both groups were correctly using the active and passive cues, as also shown by the main effect of Image in both conditions.

During the time in which the influence of the second morphosyntactic cues can be observed, the two-way interaction together with the main effect of Image in both conditions and in both time segments for the L1 children indicate that they look less consistently at the target picture for actives compared to passives, as was observed above (see discussion of time segment 2 for the 10-year-olds).

For the L2 children, the onset of the *by*-phrase seems to function as a confirming cue indicating a passive sentence. Target fixations for passives are already increasing before the processing of the *by*-phrase, and after it, they continue to increase at the same pace. The absence of interaction in comparison to the first part of the time segment (0-200 ms) and the presence of solely a main effect of Image

indicates that the L2 children now have a preference for the correct picture in both conditions.

Time segment 4: past participles

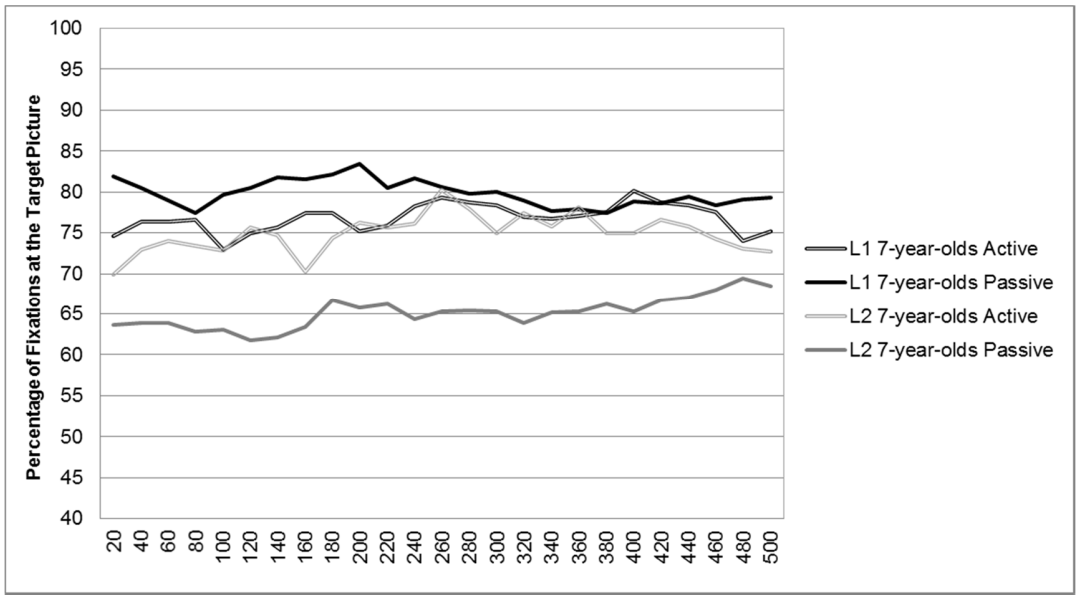


Figure 16: Gaze fixation during time segment 4: plot of age-group averages for gaze fixations from the onset of the past participle until 500 ms (active and passive sentences, correct trials only), showing percentages of fixations directed at the target picture

With the onset of the past participle we found a three-way interaction. Separate analysis by Language Group revealed a two-way interaction and main effect of Image in the separate analysis per condition in both groups. The three-way interaction was due to the opposite eye gaze patterns revealed by the two groups. Whereas the L1 children were looking more at the correct picture during passives than actives, the L2 children showed the reverse pattern. Moreover, descriptively, the accuracy of the L2 children was much lower than that of the L1 children in both conditions.

Discussion: time segment 4

The findings show that while the L1 children were processing passives at ceiling, they were less challenged in the active condition. On the other hand, the opposite pattern shown by the L2 children indicates that they were challenged to a similar degree as the L1 children by the active sentences, as target fixations were at the same level and both groups of children were at ceiling in the off-line picture-selection task.

However, during passives, the accuracy of L2 children at the end of the sentence was still lower than the L1 children.

Summary

Both groups started to interpret the sentences according to a "patient-first strategy". This preference was quickly substituted by an "agent-first strategy" that was adopted at first by the L1 and slightly after by the L2 children. Descriptively, the intensity of this preference is the same and differences can be observed concerning the time point at which it is given up. The L1 children can revise the initial wrong commitment earlier than the L2 children. Before the onset of the second passive cue, the *by*-phrase, their looks at the target pictire are already above chance. The L2 children started later than the L1 children to revise the sentence, but as well before the onset of the second cue. This suggests that the auxiliary *wurde* is for them as well a signal indicative a passive sentence. Finally, the process of revision in the L2 children is much longer and they reach the same level as the L1 children only at the end of the sentence.

3.4 General Discussion

(1) Off-line comprehension

10-year-olds

The off-line accuracy scores for both language groups were very high and not significantly different. The findings replicate previous off-line studies on passive comprehension showing that both L1 and L2 children at age 10 have almost no difficulty understanding passive sentences, suggesting that the later age of onset does not affect comprehension after 6-7 years of exposure (Root, 2014 for L1 and L2 children; Wegener, 1998 for L2 children).

7-year-olds

Even if descriptively the L2 children performed 13% lower than the L1 children in comprehending reversible passives, the difference was not significant. This finding for the L2-7-year-olds is a novel one, as it conflicts with previous studies showing that children at that age performed much lower (Becker, 2006). One possible explanation for the difference between our and the lower results obtained in Becker´s study might be the modality of the task. In the present study, the stimuli were presented orally whereas in the other study, children were asked to read the sentences. At that age the reading task might be the reason of the major difficulties of the L2-children.

(2) On-line performance during accurate trials only

Use of the "agent-first strategy"

10-year-olds

The 'agent-first strategy' seemed to be the strategy that both groups preferred to initiate sentence interpretation. This finding for German is novel. Evidence so far has shown that off-line, L1 and L2 10-year-olds weight the passive morphosyntax more heavily than the "agent-first strategy", as shown by high accuracy scores (Root,

2014), without having yet any kind of moment-by-moment insight into the use of the two cues.

7-year-olds

Both groups of 7-year-olds adopted a 'patient-first strategy' during the first NP, but they gave up this initial strategy in favour of an "agent-first strategy" slightly before they processed the active and passive auxiliaries. This preference in young children to start with a "patient-first strategy" was not expected. Further studies are needed to confirm its existence and explore potential underlying reasons. As noted, however – and in accordance with previous cross-linguistic studies (Bever, 1970; Friedmann & Novogrodsky, 2004; Huang et al., 2013; Marinis, 2007; Stromswold, under review) – both groups then started to process sentences by making use of an "agent-first strategy".

Exploitation of the active and passive morphosyntax

10-year-olds

The active and passive morphosyntactic cues triggered the same reaction in both groups. Specifically, after the processing of *wurde* in the passive condition, L1 and L2 children started at exactly the same time point to reanalyse their initial incorrect interpretation and reassign thematic roles by looking more at the congruent picture in which the first-mentioned NP is the patient. From a cognitive perspective, this finding might indicate that at age 10, children's control of response inhibition is mature enough to suppress and override an initial wrong commitment ("agent-first strategy") when conflicting cues come in. Moreover, it suggests that despite the different exposure time to the target language between the two groups, their knowledge of the passive structure and thus of the passive morphosyntax is equally well developed. An exposure time of 6-7 years seems to be sufficient for the L2 children to achieve very similar processing patterns to the ones of L1 children.

Crucially, after this exposure time, L2 10-year-olds comprehend passives in the off-line task and process them on-line like the L1 age-matched children. Furthermore, it is interesting to note that after the onset of *hat* and *wurde*, the shape of fixations on

the target and competitor picture was not symmetrical between the two conditions in both groups. There were more fixations on the competitor picture during passives than on the target picture even during actives. This finding is in line with the view that the active structure might be less challenging for the participants, leading to more random looks (as also shown in the previous study in chapter 2). On the other hand, *wurde* triggers initially in both groups an even stronger "agent-first strategy", which they both revise at the same time and to the same degree.

7-year-olds

Differences were found in our results between the L1 and L2 children concerning the point in time when *wurde* was integrated in the sentence. The L1 children started to revise their initial reliance on the "agent-first strategy" earlier during the course of the sentence and more quickly assigned a stronger value to the conflicting cue than did the L2 children. In contrast, the L2 children showed a weaker reaction to *wurde* and their target eye fixations can be observed to rise at a slower pace than do those of the L1 children.

One explanation for this might be that the L2 children assign more weight to this cue than the L1 children and that they have difficulty suppressing this initial preference when conflicting cues intervene. The 7-year-old L2 children have been exposed for a shorter time to the target language than the L1 children (respectively 3-4 vs. 6-7 years) and may be still in the process of acquiring to weight cue in a native-like manner. According to this line of reasoning, the later and slower reaction to the passive morphosyntax might be due to this briefer language exposure period. This would explain the difference between these findings and what emerged from our analysis of the 10-year-olds, in which L2 children after 6-7 years of exposure seem to have achieved the same processing pattern as L1 children. Similar patterns are found even in the off-line comprehension of the L2 7-year-olds, which even if not significantly different from that of their L1 peers, was lower than that seen in the L2 10-year-olds. Assuming that we can compare longer reaction times (see below) during self-paced listening with slower reaction times to cues during eye-tracking, the present findings converge with previous findings obtained with children at the same age in the processing of English as L2. Marinis' study (2007) documented that L2

children were sensitive to all disambiguating cues, *-ing*/*-ed* and second NP/*by*-phrase, but showed overall longer reaction times than the L1 children, suggesting quantitative rather than qualitative differences between the two groups. Importanty, in the passive condition, the difference in reaction times between the two groups was much greater than the difference in the active condition, indicating the stronger challenge posed by passive sentences.

Another explanation concerns the auxiliary *wurde* itself, which for the 7-year-old L2 children might not be as overt a cue to the passive as one would expect (note that *wurde* can also be used as a copula, as in *Der Opa wurde taub*, 'The grandpa became deaf'). It might therefore be the case that the auxiliary *wurde* triggers an initial reaction, as shown by the slow increase in target-fixations after its onset, but that due to less grammatical knowledge and/or association with the copula interpretation, the L2 children do not immediately interpret it as signalling the passive. To test whether participants' linguistic competence interacts with their reaction to the passive cue, that is, whether highly competent speakers displayed a quicker reaction to *wurde*, we conducted a descriptive analysis based on the participants' proficiency scores. Specifically, we compared the eye movements of the five L2 7-year-olds who scored best on the preliminary proficiency test with those of the five worst scorers. The descriptive analysis revealed no differences in eye movements between the two groups concerning their sensitivity to *wurde.* As overall linguistic competence does not seem to affect children's speed of reaction to cues, it does not seem to be the factor that keeps even highly competent L2 listeners from reacting like their L1 peers.

Importantly, the fact that a similar slower pattern was not detected in our analysis of the L2 10-year-olds might suggest that for the younger learners, the longer exposure to the L2 has a positive effect on their capacity to weight cues in a native-like manner.

To conclude this section, we would argue that it seems that, because of the shorter time they have been exposed to the L2 in comparison to their L1 peers and the older L1 and L2 children, the L2 7-year-olds are still in the process of acquiring the linguistic system, that is, they are still in the process of gradually fine-tuning the cues in a native-like manner. This seems to be valid also for highly competent L2 7-year-

olds and can also be observed in their slightly lower off-line scores in comparison to the L1 peers and, on-line, in their overreliance on the "agent-first strategy" and/or difficulty reacting to the passive cue.

On-line data as a window into difficulties that off-line results do not reveal

Contrary to previous studies involving younger children (7-year-olds: Adani & Fritzsche, 2015; Marinis, 2010), our eye gaze data for both 10-year-old groups provided us with a picture that differed in no way from their off-line scores. One reason for this lack of differences might be that by age 10 these particular executive functions are almost completely developed or at least concerning linguistic processing. 10-year-olds are thus able to retain their reanalysis in memory until processing is completed. It is of interest that our eye gaze data from the 10-year-olds informed us that some structures might be less challenging than others, in this case active sentences relative to passives.

On the other hand, even though both groups were successful in their off-line comprehension, data from the 7-year-olds inform us about one aspect that we would otherwise have ignored. This data showed that the L2 7-year-olds might still experience slower and more effortful processing due to an apparently different weighting of the cues involved. These findings approximate those found for English L1 children (Stromswold, under review), which revealed even during accurate trials a very weak reaction to the passive morphosyntax. With respect to this latter study, the reaction we found to the passive morphosyntax might be explained by the fact that, in comparison to the English passive, the German passive includes more reliable grammatical cues, with *wurde* being less polyvalent than *was*, which are additionally more acoustically salient than the verb suffix *–ed.* In addition, our children were older (Stromswold's study involved 5- and 6-year-olds), hence cognitively more developed, which could also explain their better on-line performance.

3.5 Conclusion

Our study reveals that the L1 and L2 child parsing systems are qualitatively identical. L1 and L2 children make use of the "agent-first strategy" to initiate sentence interpretation and can revise it when conflicting cues intervene, such as passive morphosyntactic cues.

After 6-7 years of exposure, L2 10-year-olds were shown to make the same use of the "agent-first strategy" and to react to the same degree as native-speaking peers to the active and passive morphosyntax. At the younger age of 7, after 3-4 years of L2 exposure, despite differences in proficiency, L2 children can in principle take into account the same cues in a qualitatively similar manner as L1 children and differ concerning the time point of reaction to the passive morphosyntax.

In sum, this study shows that by comparing on-line and off-line data we gained a better picture of children's linguistic knowledge. The combination of different methods, such as production data, off-line and on-line comprehension, can clearly help language researchers as well as language teachers to obtain a more precise picture of what children have acquired by a particular age. For language teachers in particular, this approach should prove useful to develop specific/tailored linguistic programs because it can help to pinpoint those linguistic cues that pose the greatest challenge for children.

4 The processing of German OVS sentences in child and adult native speakers

4.1 Introduction

When listening to transitive sentences with action verbs, speakers/comprehenders are presented with grammatical information, or cues, such as case-marking or subject-verb agreement that enables them to identify the "doer", which is the agent of an action, and the "undergoer", or patient, which is the receiver or beneficiary of the action. In addition, the expectation on the part of the comprehender that the first NP will be the subject/agent is a widespread preference cross-linguistically.

However, it is interesting to note that speakers of different languages rely on these cues and this expectation to assign thematic roles in varying degrees (Bates et al., 1984). The different strategies that speakers use cross-linguistically are related to specific properties of the language in question. For example, in free word order languages such as Russian – in which the high word order variability is correlated with the presence of a rich case-marking system (McFadden, 2003) – speakers predominantly rely on case-marking to assign thematic roles (Kempe & MacWhinney, 1999). On the other hand, in fixed word order languages such as English, due to the absence of a rich inflectional system in the language, speakers heavily base their sentence interpretation on the "agent-first strategy", assuming that the subject/agent will come before the object/patient (Kilborn, 1989).

In this context, German represents an interesting intermediate case because its ordering of the syntactic functions and thematic roles is in principle free and case (as well as number and gender) is marked on nouns, articles, adjectives and pronouns. However, in German, the case-marking system exhibits several syncretic forms and is thus more ambiguous than the Russian case system, for example. In addition, despite the flexibility of word order in German, cases of deviations from the canonical SVO order such as OVS order are comparatively less frequent than in other free word order and richly case-marked languages. This is borne out by two analyses of child-directed speech. Dittmar et al. (2008) calculated that in utterances containing two NPs, the ordering subject-before-object was present in 79% of the total cases, whereas in 21%

the first NP was marked with the accusative case and/or the second NP was marked with the nominative case. Chan et al. (2009) derived similar results, showing that the subject came first in 82% of NP combinations.

By the same token, processing studies with German-speaking adults have revealed that non-subject-initial orders have a higher processing cost even after long experience with the language (see, among others, Grewe et al., 2007; Hemforth, Konieczny, & Strube, 1993; Schlesewsky, Fanselow, Kliegl, & Krems, 2000[25]) and that adults make the assumption of a "subject-first preference" in parsing German sentences.

The same "subject-first preference" seems to be a very reliable strategy for younger learners, which they exploit from an early stage during sentence processing, even when confronted with other cues that conflict with it, such as case-marking in OVS sentences (as in *Den Hasen küsst der Hund*, 'the rabbit (ACC/O) kisses the dog (NOM/S)'. In addition, off-line studies testing child subjects on agent identification in sentences in which case-marking conflicts with the canonical agent-before-patient ordering reveal that the comprehension of OVS sentences is slightly above chance, with the children predominantly making use of the so-called "agent-first strategy" (Dittmar et al., 2008; Gamper, 2016; Roesch & Chondrogianni, 2014; Schaner-Wolles, 1989). Nevertheless, the identification scores suggest that children are capable of taking case-marking into account and do not base their interpretation on the "agent-first strategy" alone. But they weight this preference less heavily than adults do, presumably as the result of having less experience with the accusative-marked cue when it competes with the canonical word order and more generally with the OVS structure itself.

It is noteworthy that case-marking in German is acquired relatively late compared to other categories, such as verbal morphology, for instance (Clahsen, 1984; Mills, 1977; Tracy, 1986). German children initially start to apply case-marking to nouns around the age of 3, first producing nominative forms and overgeneralising them and then beginning to use accusative and dative forms correctly. At age 7 children can use nominative and accusative case-marking

[25] The study was conducted with wh-OVS questions and not declarative OVS sentences. The unambiguously masculine-marked wh-question was *welchen* 'whom'.

correctly during canonical SVO sentences (Köpcke, 2003). In comparison to other languages that also exhibit a rich case morphology such as Turkish or Russian, German children acquire case-marking relatively late. Stephany and Voeĭkova (2009) explain this in terms of the low transparency of the case-marking system. However, like in the aforementioned languages, case-marking is considered a *valid* cue in German. *Valid cues* are defined in the framework of the *Competition Model* as being both *available*, i.e., the cue is frequently used in the input, and *reliable*, i.e. reliance on this cue often leads to the correct interpretation. According to this theoretical framework, children first acquire and exploit those cues that are highly valid and later take other cues into consideration (Bates & MacWhinney, 1987,1989). It seems that in German (as well as other languages) children do not start acquiring the most valid cue – which would be case-marking with masculine NPs – as predicted by the model, but rather start to rely on the prototypical, most frequent structure, agent-before-patient with case-marking being in coalition with it.[26] The use of case-marking in isolation and thus in competition with the canonical word order is observed in a later phase. "Language acquisition is a process of first acquiring the frequently occurring coalitions of form-function mappings as prototypes […], and then gradually adjusting the weight of each mapping until it provides an optimal fit to the processing environment like the adults" (Chan et al., 2009: 295).

Another important factor affecting child language comprehension is that children´s executive functions, working memory and inhibitory control are still developing. Previous research documents that the still incomplete development of non-linguistic competencies in children is another reason, alongside less experience with case-marking in competition with the "agent-first strategy", for their low accuracy scores with OVS sentences.

Adani & Fritzsche (2015) tested comprehension by 4-year-old children of questions presenting the non-canonical word order revealing that when the children were successful in revising their initial wrong "agent-first strategy", they had more trouble than adults in holding the new correct analysis until the end of the sentence,

[26] In the framework of the *Competition Model*, what we refer to as the "agent-first strategy" is a cue that they refer to as "word order". In our conceptualisation, however, the "agent-first strategy" is not a cue but rather an interpretation preference, since one can have this strategy in mind even before the sentence starts in the absence of any cues.

as detected by monitoring the direction of their gaze at competing visual materials. In addition, when the children were asked at the end to answer the questions, they performed worse than during the on-line processing, as if they had not revised the "agent-first strategy" at all. It thus seems that during the final off-line task, when asked to finally answer the question, children's executive functions are more challenged than when they are actually listening to the questions, given that the correct sentence interpretation must persistently predominate over competing incorrect interpretations until the end of the sentence. Similar results are obtained by other studies (Huang et al., 2013; Marinis, 2010). In addition, less-developed executive functions also seem to affect the parsing process itself, thereby resulting in less successful comprehension for children compared with adults (Choi & Trueswell, 2010; Trueswell et al., 1999).

Against this background, the purpose of the present study was to investigate what on-line data can reveal to us about the weighting of cues in 7-year-olds, specifically concerning case-marking and the canonical preference, the "agent-first strategy", and whether and how their processing patterns (i.e. weighting of cues in real time) differ from those of adults. Moreover, while focusing on on-line data next to off-line data, we investigated whether the former could provide us with an additional source of insight into how children put their knowledge about case-marking to use. The two methods that we adopted were monitoring participants' eye movements relative to two pictures (on-line) and a final picture-matching task (off-line).

The chapter opens with an overview of the German case-marking system and the two types of German OVS sentences that we investigated in experiment 3.1 and 3.2. In the second section, we review studies on adult processing of OVS sentences. The third section investigates our current knowledge of the role played by executive functions during processing and children's comprehension of OVS sentences. After presenting the two experiments, the chapter concludes with a general discussion of the results and their implications.

4.2 Case-marking and OVS sentences in German

German is a verb second language (V2), meaning that in declarative main clauses and wh-questions the finite verb is obligatorily placed in second position. The first position might be occupied by any constituent, such as the subject of the sentence, resulting in the ordering SV*finO* or any other major constituent as long as the second position is occupied by the finite verb (Duden, 2009; Eisenberg, 2013; Zifonun et al., 1997). If the subject does not occur in first position, it is placed after the finite verb and often before the object. The syntactic function of the subject typically corresponds to the thematic role of agent and the object to the patient. This ordering can be inversed and the object/patient might occurr before the subject/agent, such as in OVS sentences.[27]

The German case-marking system includes four case-marking categories, nominative, accusative, dative and genitive, which are marked on determiners, pronouns, adjectives and question words and in some instances on the noun itself (e.g. dative plural, genitive singular, as well a special class of nouns, the so-called weak masculine nouns). Case in German is marked according to the gender[28] (masculine, feminine and neuter) and number (singular, plural) of the noun in the NP. Importantly, the system includes a considerable number of syncretisms that complicate the assignment of syntactic functions, as illustrated in Table 1 in the introduction.

Most of these ambiguities involve the two most frequent grammatical functions, namely the subject, expressed in the nominative case, and the direct object, expressed in the accusative. In this study, we focus on these two categories in the singular masculine and feminine gender. In German only masculine singular NPs are unambiguously case-marked, whereas feminine NPs are ambiguous between the nominative and accusative case-markings. This means that a sentence such as (1) is immediately disambiguated by the unambiguous accusative masculine case-marking

[27] Passive sentences are also a case of deviation from the canonical subject/agent-before-object/patient word order. However, unlike OVS sentences, they are non-canonical because of a syntactic/semantic mismatch. The thematic roles are inversed (patient-before-agent), whereas from a syntactic perspective they maintain the canonical syntactic order, with the subject/patient-before-object/agent.

[28] The plural forms of the three genders are indistinguishable, namely *die*.

on the first NP, whereas (2) is disambiguated later, i.e. by the unambiguous nominative masculine case-marking on the second NP.

(1) *Den Mann hat die Frau gekitzelt*
The man-MASCSGACC/UNAMB has the woman-FEMSGNOM/AMB tickled
'The woman has tickled the man'

(2) *Die Frau hat der Mann gekitzelt*
The woman-FEMSGACC/AMB has the man-MASCSGNOM/UNAMB tickled
'The man has tickled the woman'

4.3 Adult processing of OVS sentences

Several studies with German as well as with other languages allowing more or fewer word order variations provide evidence that German-speaking comprehenders have a general default tendency to start processing sentences by assigning the grammatical function of the sentence subject to an initial ambiguous NP ("subject-first preference"; among others for German, Bader & Meng, 2000; Hemforth et al., 1993 Schlesewsky et al., 2000; for Italian, De Vincenzi, 1991; for Turkish, Demiral, Schlesewsky, & Bornkessel-Schlesewsky, 2008; for Dutch, Frazier & Flores D'Arcais, 1989).

In the literature, there are different explanations for this preference. Within a pure syntactically-based perspective, in the framework of the *Government and Binding Theory* (Chomsky, 1981) and some following accounts, such as the *Active Filler Strategy* (Frazier & Clifton, 1989.), the *Minimal Chain Principle* (De Vincenzi, 1991), and *Minimal Attachment* (Frazier & Fodor, 1978) and/or *Simplicity* (Gorrell, 2000) accounts, this preference is the result of universal parsing principles dictating the parser to build the simplest and most parsimonious phrase-structure representation that does not violate principles of grammar.

Considering models in which syntactic principles are combined with non-linguistic factors such as working memory (Gibson, 1998; Schlesewsky et al., 2000), this preference is explained by arguing that any object before the subject would trigger higher memory costs because more items have to be kept in the working memory until the onset of the subject.

Finally, within a frequency-based perspective, this preference applies because the position of the subject before the object is much more frequent in German (Chan et al., 2009; Dittmar et al., 2008) and corresponds to the dominant word order across languages (Dryer, 1995).

Most on-line studies conducted in German with OVS sentences have focused on their greater complexity in comparison to SVO sentences and particularly on the difficulties that comprehenders encounter during their processing using methods such as the self-paced reading task, eye-tracking during reading (e.g. Hemforth et al., 1993; Hopp, 2006; Schlesewsky et al., 2000) or neurolinguistic methods (Fiebach,

Schlesewsky, & Friederici, 2001; Rösler, Pechmann, Streb, Röder, & Hennighausen, 1998.; see also Friederici, 2015 for an overview). Given that the purpose of the current study is to provide a picture of how 7-year-olds and adults weight cues in real time and at what point in the sentence this occurs, rather than showing whether they reveal greater difficulty in processing OVS sentences that SVO sentences, we will not pursue the matter in further detail here.

Friederici, Steinhauer and Mecklinger (1998) provided a contribution to the relation between sentences whose disambiguation point occurs early or late in the sentence and comprehenders' working memory. In the study, participants exhibiting long and short working memory were tested while reading object-relative sentences disambiguated at three different points. The results showed that both participant groups were capable of immediately integrating the earliest-occurring cue (an accusative case-marked pronoun) and beginning to revise their initial assumption, as demonstrated by the presence of ERP positivities during EEGs. However, differences between long and short working memory participants were found both off-line and on-line when the disambiguation point occurred sentence-finally, with the short span readers not showing involvement in any revision process at the onset of the disambiguating cue. For our study, this finding might imply that long-lasting ambiguities are particularly challenging for participants exhibiting shorter working memory, as is the case with young learners.

Importantly, the finding that the length of the ambiguous region generally affects the strength of the garden-path effect has been demonstrated by other studies (Bader & Meng, 2000; Ferreira & Henderson, 1991). The longer the ambiguous region, the more the parser has to suppress those interpretative processes, which have been confirmed by those cues that the parser has thus far at its disposal. In a similar vein, Bates and MacWhinney (1989) posit that during sentence processing, the parser is continuously updating the information it encounters, based upon which it formulates a hypothesis about the most plausible interpretation, thus being garden-pathed when the resulting interpretation must be revised. The longer the parser accumulates the cues and produces an interpretation of the sentence, the more difficult it is to revise this interpretation when conflicting cues emerge (also Hale, 2001 for a similar account).

Bahlmann, Rodriguez-Fornells and Rotte (2007) suggest that the two types of OVS sentences in which the point of disambiguation occurs either immediately or late in the sentence present different types of difficulty as they involve distinct neural activations and processing. On the one hand, when the disambiguating point occurs sentence-initially, the object is immediately unambiguous so the OVS is recognised as such, and the difficulty for the parser comprises keeping the syntactic cue in memory until the onset of the projected subject. On the other hand, when the disambiguating cue emerges late in the sentence, assuming the use of a "subject-first preference", a complex syntactic reanalysis is required at the end rather than an effort to maintain cues in working memory throughout the sentence.

Eye-tracking studies using the *Visual World Paradigm* (Tanenhaus et al., 1995) to test participants on temporarily ambiguous SVO and OVS sentences (Kamide et al., 2003; Knoeferle et al., 2005; Weber, Grice & Crocker, 2006) and both types of OVS sentences – unambiguous and temporarily ambiguous sentences (Wendt, Brand & Kollmeier, 2014) – agree with the finding that German adults start interpreting sentences with the "agent-first strategy". This preference is incrementally revised with the onset of the accusative-marked NP in unambiguous OVS sentences or with the onset of the nominative-marked NP in temporarily ambiguous OVS sentences.

In sum, this review of studies reveals that adults show a preference for interpreting ambiguous and temporarily ambiguous OVS sentences with a "subject/agent-first strategy", but they incrementally revise this initial wrong interpretation as cues conflicting with this interpretation emerge. Crucially, OVS sentences starting with an unambiguous NP – thus unambiguous from the start – are easier to process than when the disambiguating cue occurs later during the second NP. The length of the ambiguous region affects the weight that participants give to initial cues or expectations and causes them difficulty when they need to abandon the initial incorrect strategy and start the revision process. For this reason, the two types of sentences seem to involve different strengths and processing mechanisms. In addition, the degree of their success in correctly interpreting and processing such sentences is also related to the comprehenders' executive function capacities.

4.4 Cognitive competences in monolingual children and adults

There are two factors that might account for differences between children and adults in terms of their use of cues during sentence processing: linguistic knowledge and general cognitive competences. Recent studies have provided evidence that several behaviours in children's sentence comprehension may be related to their immature executive functions, including all three of these functions, namely working memory, inhibition and cognitive flexibility (Diamond, 2013; Lehto et al., 2003; Miyake et al., 2000).

For the sake of our study, in order to make predictions concerning how children could differ from adults in the processing of OVS sentences, we will initially focus on how first a less-developed verbal working memory – i.e. the component of memory that stores and manipulates verbal information (Baddeley & Hitch, 1994) – and second a less-developed inhibitory control system – i.e. the ability to suppress stimuli, information or impulses that are irrelevant to current demands (Parasuraman, 1998; see Mazuka, Jincho & Oishi, 2009 for an overview of the topic) – might affect children's sentence processing.

It is well known that children have a shorter working memory span than adults (see, among others, Gathercole, Pickering, Ambridge, & Wearing, 2004), implying that their capacity to integrate and store information during processing is less efficient than in adults. Studies document that 6- and 7-year-olds are not capable of integrating and taking into consideration multiple cues like adults do and relate this to their limited working memory capacities. Felser et al. (2003) showed that children solved relative clause attachments by primarily considering structural information, while adults were also influenced by semantic factors. The authors argued that children's sensitivity to semantic information is not absent, but rather that the integration of non-structural cues requires additional processing resources, which represents a challenge for the more limited working memory of the children. In addition, further studies reported evidence that despite undertaking the same qualitative exploitation of cues, children were slower than adults in integrating certain cues such as accessing non-preferred referents while processing ambiguous pronouns (Sekerina, Karin, & Arild, 2004).

With regard to the relation between working memory and verbal storing, child on-line data often reveal a stronger knowledge of the relevant linguistic cues than what suggested by the off-line data. It seems that although the final sentence interpretation during the off-line task is erroneous that it does not necessarily suggest poor linguistic knowledge of the cues. The studies reveal that even if children were not performing at high level at the end of the structures under investigation, while listening to the sentences, during the on-line processing, they were exploiting the cues correctly, thus indicating knowledge of the structure. It might thus be that children's shorter working memory might affect their capacity to store cues and keep them in consideration until the end of the sentence.

In sum, we can conclude that due to children's shorter working memory, we might expect children to take longer than the adults in integrating new cues, such as the accusative case-marked NP in unambiguous sentences and the nominative case-marked NP in temporarily ambiguous sentences. Despite Felser et al. (2003) reveal that children were unable to integrate semantic cues, but only syntactic ones, we predict that our children would rely on the "agent-first strategy" as this might not be related to a semantic cue but rather be considered a linear syntactic-semantic-pragmatic expectation while processing sentences. With respect to the storing aspect, we expect the children to have more difficulties than adults with unambiguous OVS sentences in keeping the new OVS interpretation until the end.

Along with children's short working memory capacities, their poor inhibitory control has been used to explain the so-called *kindergarten-path effect* according to which 5-year-old children have difficulties in revising initial wrong parsing choices (Trueswell et al., 1999 for English; Choi & Trueswell, 2010 for Korean). Evidence comes from an eye-tracking study in which children were asked to act out sentences such as *put the frog on the napkin in the box* in front of a visual context, including one condition with two frogs, one on a napkin and one not, and an empty box. Eye gaze data revealed that children interpreted *on the napkin* as the goal of the action and could not re-analyse this incorrect interpretation after having heard *in the box*. A similar experiment was conducted in Korean, a head-final language, in which children were presented with sentences such as *napkin-frog-pick up* and *napkin-frog-put* where the point of disambiguation was on the final verb, as the case-marked first

NP was ambiguous between a locative (*put*) and genitive (*pick up*) interpretation. Similar to the English 5-year-olds, Korean children showed a general tendency to interpret the first NP with a locative interpretation without being able to revise this incorrect assignment with the onset of the disambiguating verb *pick up*.

In sum, from this brief overview of children's inhibitory control, it may be concluded that it would probably be particularly difficult for children to correctly interpret non-canonical sentences in which the disambiguating cue emerges late in the sentence.

4.5 Acquisition of case-marking and its use to disambiguate OVS sentences

4.5.1 Off-line comprehension studies with monolingual children

The use of the "agent-first strategy" seems to be the first strategy that children make use of to comprehend sentences. Dittmar et al. (2008) showed using an act-out task with novel verbs that German children at first interpret correctly only those sentences in which the agent-action-patient ordering is in coalition with case-marking (*Der Hund wieft den Löwen* 'the dog-MASCSGNOM weefs the lion-MASCSGACC') and only later comprehend structures such as OVS in which the canonical expectation is in competition with case-marking (*Den Bären wieft der Tiger*, 'the bear-MASCSGACC weefs the tiger-MASCSGNOM'). Importantly, at the age of 7, children correctly acted out 69% of unambiguous OVS sentences, starting with a masculine first NP while being at ceiling in the prototypical condition. A similar study conducted by Schaner-Wolles (1989) showed that 5-year-old children in the presence of a first unambiguous accusative NP were already performing above chance (89%) in selecting the correct picture. However, this study was not conducted with novel verbs, which might be the reason for the lower performance of the 7-year-olds in Dittmar et al.'s (2008) study. Other studies such as Mills (1977) and Lindner (2003)[29]

[29] In Lindner's (2003) study, several factors were manipulated, also resulting in ungrammatical sentences. For the sake of our study, only one sentence type is of interest, exemplified by *Den Klotz der Frosch schubst*, 'the block (MASCSGACC/UNAMB) the frog (MASCSGNOM/UNAMB) pushes'), in which the "agent-first strategy" competes with case-marking. However, this sentence corresponds to any grammatical sentence in German semant main clauses.

conducted with real verbs using an act-out task – akin to Dittmar et al. (2008) – in which 5-year-olds had to play the double task of hearing and playing out the sentences reported lower scores than those in Schaner-Wolles (1989). Lindner (2003) suggests that the difference in results may be methodological in origin, as the task of acting out sentences is more demanding than the picture selection task in Schaner-Wolles (1989).

Studies testing children with the two type of OVS sentences illustrated in section 4.2, namely unambiguous and temporarily ambiguous OVS sentences, document overall lower performance and substantial differences between the two conditions. Biran and Ruigendijk (2015) tested German 6-year-olds and found that they were correctly interpreting 46% of the unambiguous OVS sentences and performed worse (33%) when the point of disambiguation was late, on the second NP. Gamper (2016) manipulated also the animacy factor and showed that German 9-year-olds performed better when the first NP was unambiguosly case-marked than when it was feminine or neuter. Roesch and Chondrogianni (2014) detected higher scores slightly below the 80% line in 5-year-olds during the processing of unambiguous object wh-questions. These higher scores might be due to the fact that, in comparison to declarative sentences, questions do not differ with respect to markedness, whereas object-first declarative sentences presuppose a special information structure of the context of the sentence, in line with the pragmatic topicalisation of the object (Musan, 2010).

In sum, these findings provide evidence that OVS sentences are often misinterpreted by children, and, in line with previous studies with adults, OVS sentences that are temporarily ambiguous are much more challenging than unambiguous ones. The length of the ambiguous region seems to play a decisive role and, as Mills (1977) further suggested, the unambiguous NP in initial position also facilitates comprehension due to its saliency of initial position, whereas an unmarked form in the same place creates the expectation of a following accusative argument, making the disambiguating nominative-marked second NP frequently overlooked.

4.5.2 On-line processing studies with monolingual children

In an eye-tracking study on the processing of non-canonical sentences, Adani and Fritzsche (2015) monitored the eye gaze movements of 4-year-olds while processing subject and object relative clauses (*Wo ist die Kuh die den Hund jagt?* 'Where is the cow that chases the dog-MASCSGACC?'; *Wo ist die Kuh die der Hund jagt?* 'Where is the cow that the dog-MASCSGNOM chases?'). The visual material consisted of three movie clips positioned at the right, middle and left of the screen and displaying cartoon animals. The animal in the middle was the referent of the embedded noun in the relative clause (e.g. *der Hund*/*den Hund*) while on the right and left was placed the referent that participants had to disambiguate as the agent or patient of the action (e.g. *die Kuh*). In order to recognize whether *die Kuh* was agent or patient, participants had to wait until the onset of the second nominative- or accusative-marked masculine NP. Assuming that children make use of an "agent-first strategy", thus interpreting *die Kuh* as the agent, in order to correctly interpret object relative clauses, they should suppress this strategy after the onset of the unexpected nominative-marked second NP (*der Hund*). The results of the study revealed that during object relative clauses, gaze fixations to the correct referent can be detected through eye-tracking even if at the end this pattern remains hidden in the off-line scores. Children succeed in revising the wrong "agent-first strategy", but they are no longer able to retain this revision by the time they are performing the off-line task, in which they are asked to answer the question of who the agent/patient is (36% correct answers against the ceiling performance of adults). Crucially, the processing patterns of children and adults were similar, since the same statistical effects were found. Differences were detected only in the size of these effects. The authors conclude that at age 4 children rely stronger on the "agent-first strategy" and find it difficult to suppress: "knowledge of the linguistic structure itself is not enough for evaluating this structure by making a decision" (p. 24) .

As described in the previous section (4.4) concerning the non-linguistic differences between children and adults, this study provides evidence that the poor performance of children with OVS sentences results from extra-linguistic processes

that appear to hinder the young learners from successfully selecting the picture that correctly matches the sentence.

Overall, the present review of off-line and on-line studies demonstrates that children's performance with OVS sentences improves with age, indicating that a reliance on the "agent-first strategy" diminishes as the child is increasingly able to make use of case-marking in isolation to assign thematic roles. The position of the disambiguating cue seems to decisively influence their comprehension, contributing to their lower off-line scores. Finally, the collection of on-line data alongside off-line data provides us with further insights into the child's linguistic knowledge. The demands of the off-line task can negatively affect their final interpretation of the sentence, while on-line data shows us their effective knowledge of the structures.

4.6 Study 3

4.6.1 Overview and research questions

In the current study, we examined how adults and children understand and process German SVO and OVS sentences of two types. In experiment 3.1, we tested participants on SVO and OVS sentences that were unambiguous because the first masculine NP was respectively nominative and accusative-marked. In experiment 3.2, we investigated SVO and OVS sentences that were temporarily ambiguous because the first feminine NP was ambiguous between a nominative and accusative interpretation. In experiment 3.2, both sentences were disambiguated at a later point than in experiment 3.1, namely by the second masculine NP being respectively accusative and nominative-marked.

The research questions that we address in the current study are as follows:

(1) How do adults and children understand the two type of OVS sentences off-line?

We expect that OVS sentences will generally be more difficult than SVO sentences (see, among others, Dittmar et al., 2008; Hopp, 2006) for both groups and that, precisely because of their temporary ambiguity, temporarily ambiguous OVS sentences (experiment 3.2) will be harder to interpret than unambiguous OVS

sentences (experiment 3.1) (Bahlmann et al., 2007; Biran & Ruigendijk, 2015; Mills, 1977; Schaner-Wolles, 1989).

(2) Are there differences between adults and children in terms of how they process sentences on-line? More precisely, do they make on-line use of the morphosyntactic cues?

For experiment 3.1: Do they exploit the first disambiguating cue, the masculine accusative-marked *den*, to revise the expected "agent-first strategy" documented thus far in the literature (Bader & Meng, 2000; Hemforth et al., 1993; Knoeferle et al., 2005; Schlesewsky et al., 2000) and retain the new analysis in working memory until the end of the sentence (in a similar vein, Bahlmann et al., 2007)? We expect the children to have more difficulty with this due to their less-developed working memory system and their stronger reliance on an "agent-first strategy", as shown by previous off-line studies (e.g. Dittmar et al., 2008; Mills, 1977).

For experiment 3.2: Do they exploit the disambiguating cue on the second NP to re-analyse the expected "agent-first strategy" at a much later point in the sentence? We expect both groups to have difficulty here, as shown by previous studies with adults (e.g. Friederici et al., 1998) and children due to the longer ambiguous region (e.g. Choi & Trueswell, 2010; Trueswell et al., 1999)

(3) Are there differences between off-line and on-line performance in both groups?

Due to children's overall less mature executive function system, we may be able to derive interesting additional insights from the analysis of the on-line data rather than considering off-line data alone (Adani & Fritzsche, 2015; Marinis, 2010).

For experiment 3.1: We expect that children will be sensitive to the accusative-marked article *den* yet challenged when it comes to retaining this interpretation in working memory until the off-line task, when they have to select the correct picture, because of the effort required by a sustained suppression of the "agent-first strategy".

For experiment 3.2: We expect that even if children react to the second disambiguating cue, they will perform better on-line than off-line, because they have to not only revise their interpretation of the sentence but also mantain the revision until the end of the sentence.

4.6.2 Experiment 3.1: Study with unambiguous SVO and OVS sentences

4.6.2.1 Participants

Thirteen monolingual German-speaking adults (9 female and 4 male) and ten seven-year-old monolingual German-speaking children (5 female and 5 male; age range = 7.1-7.8; mean age 7,5 years; SD = .2449) participated. Adults were university students, whereas children attended the first year of the German primary school system. For their participation in the study, participants received course credits and a child-friendly certificate, respectively.

4.6.2.2 Materials

Sixteen experimental sentences were created. Each sentence was presented in either the SVO or OVS condition (within-subject experimental condition) and was paired with a picture (Figure 17).

(3) *Der Vater hat am Abend die Mutter sehr lange geküsst*
The father-MASCSGNOM/UNAMB has-AUX in the evening-ADV the mother-FEMSG/AMB very long-ADV kissed-PPART

(4) *Den Vater hat am Abend die Mutter sehr lange geküsst*
The man-MASCSGACC/UNAMB has-AUX in the evening-ADV the mother-FEMSG/AMB very long-ADV kissed-PPART

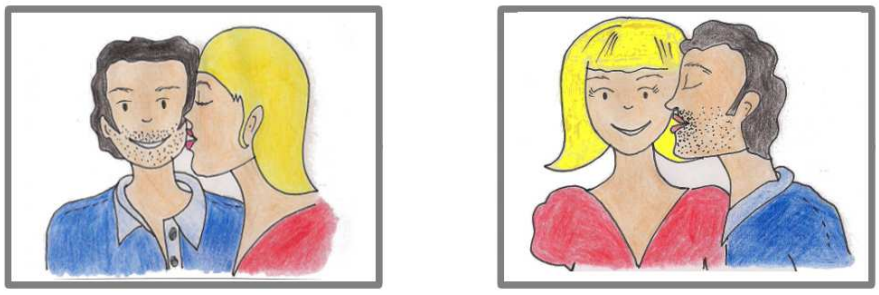


Figure 17: Example of a picture for experimental sentences 3 and 4 of experiment 3.1 (and 5 and 6 of experiment 3.2)

The first NP in both sentence types has masculine gender, which leads to unambiguous nominative and accusative case markers. The second NP has feminine gender, which is ambiguous between nominative and accusative.

All experimental items were semantically reversible to avoid participants using semantic cues for the assignment of thematic roles. We choose eight verbs expressing actions happening between an animate agent and an animate patient and positioned in a semantic continuum ranging from affectionate to aggressive actions. The verbs were *kitzeln* 'tickle', *küssen* 'kiss', *streicheln* 'caress', *waschen* 'wash', *wecken* 'wake up', *treten* kick', *hauen* 'beat' and *schubsen* 'push'. Four pairs of agent/patient comprising a masculine and a feminine NP were used *Mann/Frau* 'man/woman', *Opa/Oma* 'grandpa/grandma', *Vater/Mutter* 'father/mother' and *Bruder/Schwester* 'brother/sister'. Each verb appeared twice and each character pair four times within a list, whereby all characters had the role of subject/agent and object/patient in both SVO and OVS sentences. Adverbials comprising two or three syllables were added to each sentence, one temporal adverbial after the auxiliary and one manner adverbial before the past participle. This ensured that there was sufficient time to measure the effect of a given grammatical cue during sentence processing before the onset of the next cue. The sentences were read by a female native German speaker with normal declarative intonation and speed, digitally recorded with a high quality microphone and laptop computer in an acoustically insulated chamber. The recorded sentences were subsequently cross-spliced to prevent SVO/OVS sentence intonation from contribute to disambiguation. This was accomplished by taking the first NP, the manner adverbial and the past participle from the SVO sentences and splicing them into the OVS sentences and vice versa, whereby all test items were counter-balanced.
For the visual context, the sixteen pairs of pictures were created displaying the action described in the sentence once with a congruent (target picture) and once with reversed assignment of thematic roles (competitor picture). In the picture pairs, the agent appeared to the left and right of the patient equally often and each of the eight characters was also presented on the left or right in the pictures an equal number of times. All pictures were drawn the same size and did not contain any visual cues that could make one picture more attractive than the other. The target picture was shown on the left in half of the trials and on the right in the other half.

Twelve warm-up items were constructed in which participants had to select the correct picture of a single protagonist. For example, they heard *Das ist der Opa* 'This is the grandpa' and were shown two pictures, one showing a grandpa and the other a grandma. The aim was to introduce the characters to the participants and familiarise them with the eye-tracking task. Eight of the characters in the warm-up items corresponded to the characters in the experimental items and four were proper names referring to the characters appearing in the filler items. Sixteen filler items were distributed among the experimental items to prevent participants from guessing the purpose of the experiment and developing any response strategies. The filler items comprised sixteen transitive sentences containing the three different modal verbs *sollte* 'should', *musste* 'had to' and *wollte* 'wanted to'. The experimental sentences were organised into two stimulus lists. For each list, participants listened to sixteen experimental items (eight SVO and eight OVS), sixteen filler items and twelve warm-up items. Since each experimental item was presented in two conditions, thirty-two experimental sentences were constructed (see Appendix B.3 for the full set of experimental sentences separated into the two lists). The same pair of pictures was used for both versions of each experimental item. For the warm-up and filler items, six and sixteen pairs of pictures were created, respectively (the complete set of pictures is provided in Appendix B.4).

4.6.2.3 Procedure

All participants were tested individually in a quiet room with constant lighting. Participants sat in front of 21-inch Samsung screen at a distance of approximately 50cm, with the experimenter sat on their right. The visual stimuli were WMV files created using Windows Movie Maker 2.6 and presented with a resolution of 1920x1080 pixels. Participants´ eye movements were monitored by the Tobii X1 Light Eye-tracker. Eye movements were logged by the Tobii Studio software running on a DELL netbook positioned in front of the experimenter. Both eyes were recorded. Before the start of the experiment, participants were instructed to listen to the sentences until the end and subsequently select the picture that matched the given sentence by pressing one of two buttons on a keyboard (*Visual World Paradigm*,

Tanenhaus et al., 1995), which provided us with the accuracy results. Before the start of the experiment, participants were automatically calibrated using a nine-point gaze fixation pattern and – when requested by the system – a re-calibration was carried out between the trials. After every experimental video, participants were shown a rewarding picture. Before the onset of the experimental sentences, the pairs of pictures were presented with a preview time of 2500ms. The experiment lasted approximately 20 minutes.

4.6.2.4 Coding

For the analysis of the eye-tracking data, the experimental sentences were divided into three main time segments. Table 5 below provides an overview of the time segments:

	Time Segment 1	**Time Segment 2**	**Time Segment 3**		
	Sentence Onset 200+500ms (1stNP)	**Onset AUX 200-900ms**	**Onset 2nd NP + PPART 200-700ms**	**700-1400ms**	**1400-2100ms**
SVO	Der Vater	hat am Abend	die Mutter sehr lange geküsst		
OVS	Den Vater	hat am Abend	die Mutter sehr lange geküsst		

Table 5: Time segments (Experiment 3.1 of study 3), selected on the basis of cue onset

Time segment 1 includes the first and unique disambiguating morphosyntactic cue, the first masculine NP. The second time segment corresponds to the onset of the auxiliary and the adverb, which do not provide any further cues for disambiguation between a SVO and OVS sentence interpretation. Finally, time segment 3 includes the second NP, which bears feminine gender and is thus ambiguous. Due to the length between the onset of the feminine second NP until the end of the sentence, we separated it into three segments to achieve a more detailed analysis. Segment onsets were calculated on a sentence-by-sentence basis. Since the programming and execution of a saccade takes place 200 ms after the reception of the associated verbal input (Matin et al., 1993; Rayner, 1998), statistical analysis for each time segment began 200 ms after the onset of the time segment.

The length of each time segment was established taking into consideration the average, earliest and latest onset of the subsequent cues in the next time segment.[30] Segment 1 lasted 500 ms because the earliest onset of the first cue, the auxiliaries, occurred at 398 ms and since the programming of a saccade needs 200 ms, we guaranteed that any effects during this segment were affected by the onset of the auxiliaries. Segment 2 lasted 900 ms since the onset of the second cue occurred at 1074 ms.

Both accuracy and eye movement data were analysed with logistic mixed effect models using R (R development Core Team, 2012) and the R packages *lme4* (Bates, Mächler, Bolker, & Walker, 2015) and *languageR* (Baayen, 2008).

In the results section, we will report the results for each time segment. The effects of interest for our research questions are the main effects of Image or interactions between Image and Sentence type, Image and Age Group or a three-way-interaction between Image, Age Group and Sentence Type. A main effect of Image means that the subject's gaze was fixed on congruent and incongruent images to significantly different degrees. An interaction of Image and Sentence Type would indicate that the preference for the congruent over the incongruent image (or vice versa) is not the same in the two experimental conditions or also that the interaction differs concerning its intensity. Finally, interactions with Age Group indicate that these effects differed between age groups.[31] All effects for each time segment are reported in Appendix D.3.

Possible eye movement patterns

If children look at the congruent and incongruent picture equally often (50% target looks), this does not allow for any conclusions regarding their processing strategies. If they look at the congruent picture more than 50%, they are using a strategy that leads to the correct interpretation of the sentence. On the other hand, if they look at the target picture less than 50%, that they are using a strategy that leads to the

[30] Earliest, mean and latest time of, respectively, Onset 1 (auxiliary), 398, 600, 1097 ms; Onset 2 (2nd NP), 1074, 1250, 1779 ms; measured from the previous onset.

[31] We will not discuss main effects of Age Group, Sentence Type or interactions of Sentence Type and Age Group as we have no hypotheses for these factors.

incorrect interpretation of the sentence. We expect a mirror image for SVO and OVS (e.g. 60% target looks for SVO and 40% for OVS) if children make use of an "agent-first strategy", thus being on the right track during SVO and not during OVS. If there is mirror image that is not symmetrical, whereby the value from chance looking is greater for one of the two sentence types (70% target looks for SVO and 40% for OVS), this means that there is a cue in one of the two conditions of which they make more use.

4.6.2.5 Results

4.6.2.5.1 Accuracy

The adults were highly accurate in both conditions, with a mean accuracy rate of 95.2% for SVO and 93.3% for OVS.[32] The 7-year-olds reached similar results in the SVO condition at 92.5%, whereas in the OVS condition their performance was only slightly above chance, at 56%.[33] For the accuracy data, the dependent variable was whether participants chose the target or competitor picture. The model contained Age (adults, 7-year-olds) and Sentence Type (SVO, OVS) as well as their interaction and participants and items as random factors including individual slopes for Age and Sentence Type (lmer and binomial family in R) (Baayen, 2008; Barr et al., 2013; Barr et al. 2013; Jaeger, 2008). We found a main effect of Age Group (estimate = -2.9446, std. = 0.7350, z = -4.006, p = 0) and a significant interaction between Age Group and Sentence Type (estimate = 2.1800, std. = 0.8718, z = 2.501, p = 0.01). Separate analysis divided per sentence type revealed no main effect of Age Group during SVO sentences (estimate = -0.7335, std. = 0.7887, z = -0.930, p = 0.352) whereas during OVS sentences the main effect achieved significance (estimate = -2.9718, std. = 0.7976, z = -3.726, p = 0). This indicates that during SVO sentences the two groups did not differ, whereas during OVS sentences their performance was different.

[32] Two trials (2%) overall were excluded from the analysis of the adults (one in the SVO and one in the OVS condition) because participants elicited no answer.

[33] One trial during an OVS sentence was excluded from the analysis (1.25%) because no answer was detected.

4.6.2.5.2 Eye movement data

In the following, for the eye movement data, the dependent variable was the sum of gaze fixations on the target or competitor picture. Trials without answers were excluded from the analyses. We analysed fixations to the target and competitor picture in 20ms intervals. The sum of these gaze fixations was subsequently computed for each time segment. For all data sets, we first computed a full model including a three-way interaction of the fixed factors, Age group (adults, 7-year-olds), Image (congruent, incongruent) and Sentence Type (SVO, OVS), as well as participants and items as random effects including random slopes by participants and by items for all fixed factors and their interactions (Barr et al., 2013; Baayen, 2008; Jaeger, 2008). In cases where the full model did not converge, interaction terms were removed from the random slopes of the model. The first converging model was defined as the maximum model, against which all simpler models were compared by a log-likelihood ratio test with the anova function in R (see e.g. Barr et al., 2013). Model comparisons assured that the model containing the interactions was a significantly better fit to the data than a simpler model with just the three main effects. In all analyses presented in the following, the model with all fixed effects and their interactions proved to be better than simpler models.

Figure 18 plots the percentage of fixations on the target picture out of all fixations on either the target or competitor picture in the SVO and OVS condition for the full time-course of the experimental sentences.

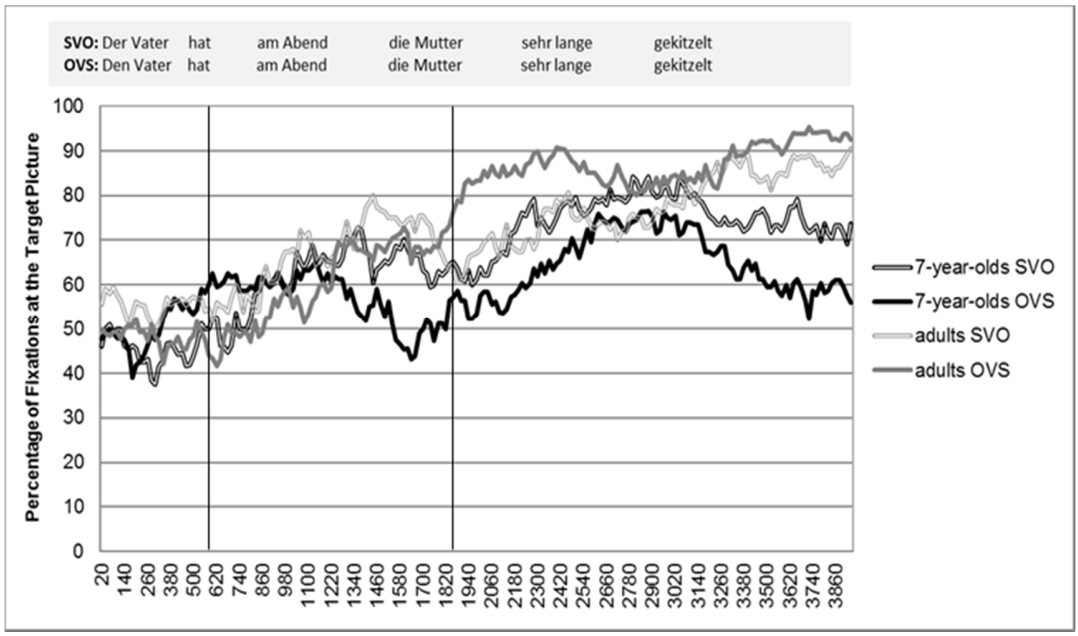


Figure 18: Plot of age-group averages for gaze fixations from start to finish of trial (SVO and OVS sentences with masculine first NP, correct and incorrect trials), showing percentages of fixations directed at the target picture

Descriptively, it can be seen in Figure 18 that both participant groups interpreted the sentences by making on-line use of the morphosyntactic cues, given that target fixations did not remain at chance level. Importantly, whereas target fixations of both groups during SVO sentences reveal almost the same increasing pattern, during OVS sentences the two groups show differences: adults make use of the disambiguating accusative cue at the very beginning around 680ms, compared with children at a later time point around 1660ms. Furthermore, while adults were at ceiling at the end of the sentences, children´s target fixations decrease in the last section after a peak at the 75% line and end at chance level.

Time Segment 1: unambiguous masculine first NP (SVO, der Vater; OVS, den Vater)

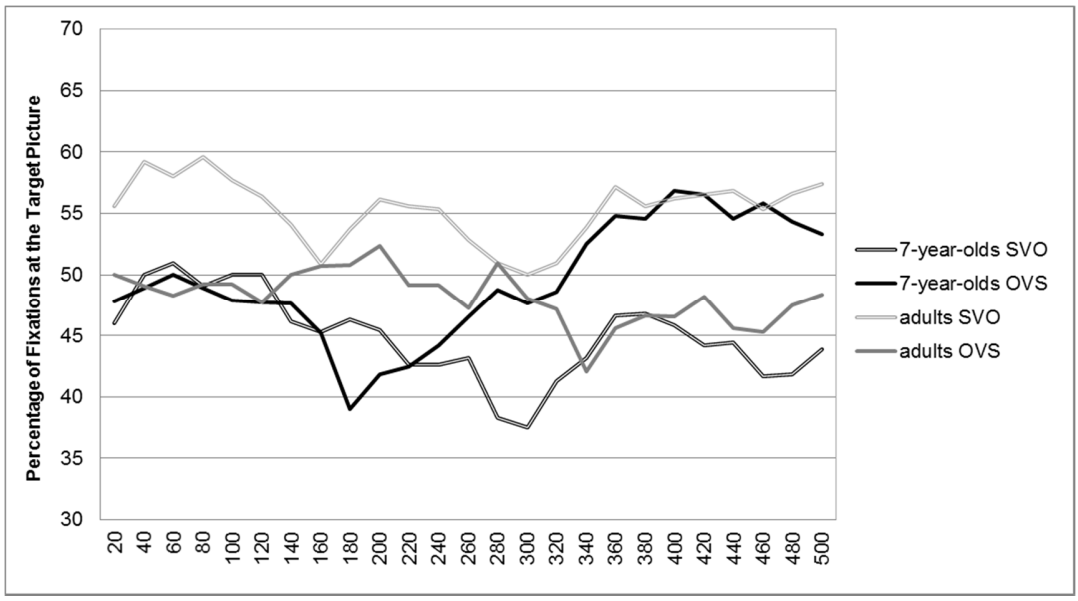


Figure 19: Gaze fixation during the unambiguous masculine nominative or accusative first NP: plot of age-group averages for gaze fixations from start of trial (SVO and OVS sentences with masculine first NP, correct and incorrect trials) until 500 ms, showing percentages of fixations directed at the target picture

During the first nominative- or accusative-marked NP, we found a three-way interaction between Image, Age Group and Sentence Type. Separate analysis of the interaction divided per age group shows a two-way interaction of Image and Sentence Type in both groups. This was due to more gazes directed at the target than the competitor picture during SVO sentences, while the opposite was true in the OVS condition. Further separate analysis per Sentence Type showed a main effect of Image during SVO sentences only and in both age groups. Moreover, this strategy was more pronounced among the 7-year-olds than in the adults, which explains the significant three-way interaction.

Discussion: Time Segment 1

The results show that both groups started to interpret the sentences according to an "agent-first strategy". The nominative marker in the SVO condition triggered more target fixations in both groups than the accusative cue in the OVS condition. The use of this strategy was more pronounced among the 7-year-olds than the adults.

Nevertheless, as we can observe descriptively, the effects are very minimal and target fixations do not strongly deviate from chance level.

Time Segment 2: auxiliary (SVO/OVS, hat)

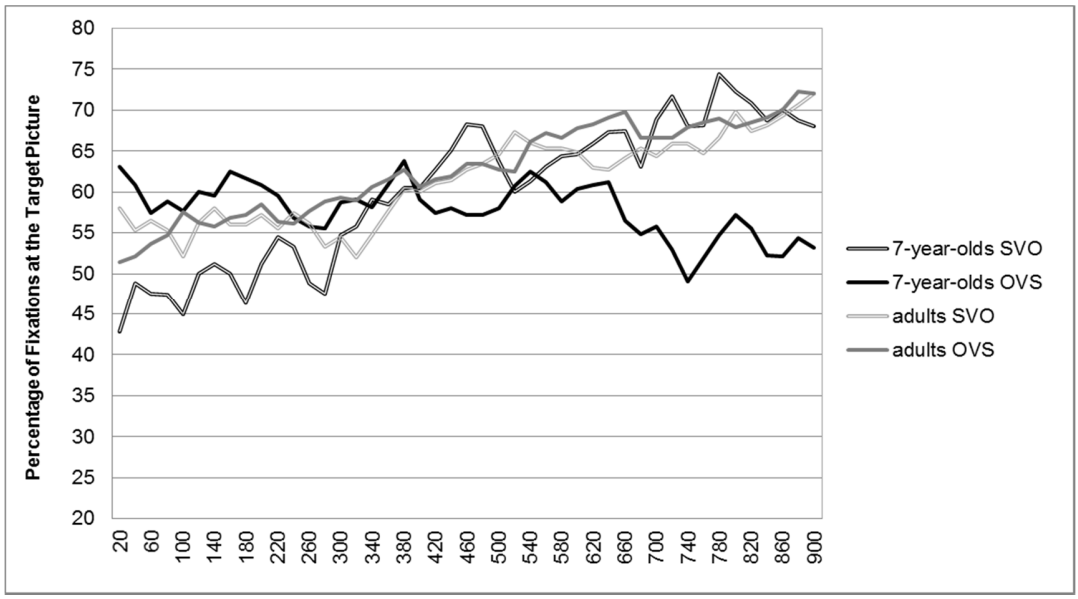


Figure 20: Gaze fixation during the auxiliary and the adverb: plot of age-group averages for gaze fixations from the onset of auxiliaries until 900 ms (SVO and OVS sentences with masculine first NP, correct and incorrect trials), showing percentages of fixations directed at the target picture

During this segment, no further disambiguating cue is provided. The three-way interaction between Image, Age Group and Sentence Type reached significance. Separate analysis per Age Group revealed for the adults a main effect of Image with no additional effects and for the 7-year-olds a main effect of Image and a two-way interaction of Image and Sentence Type. The interaction breaks down into two main effects of Image during both SVO and OVS sentences.

Discussion: Time Segment 2

The main effect of Image in the analysis of the adults indicates that they were looking more at the target picture in both conditions, i.e. they were exploiting the respective masculine disambiguating markers. Descriptively, we can see that target fixations in both conditions were raising at the same pace. On the other hand, the interaction found for the 7-year-olds indicates a stronger preference for looking at the target

picture during SVO rather than OVS sentences, thereby showing that the accusative marker did not lead to as many fixations to the target image as the nominative marker.

Time Segment 3: 2nd NP (SVO/OVS, die Mutter) + past participle

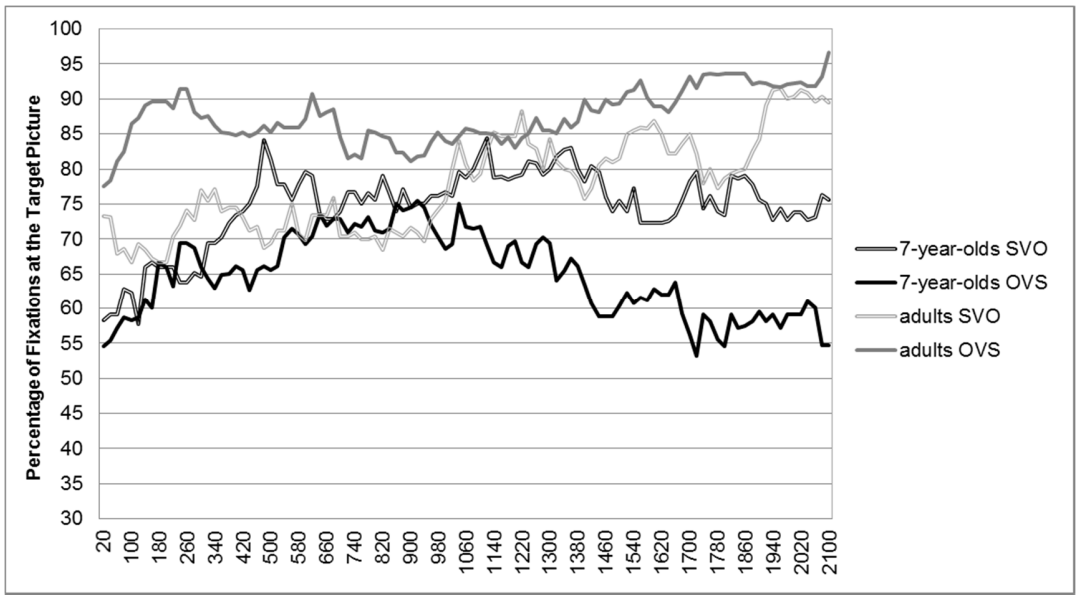


Figure 21: Gaze fixation during the 2nd NP, adverb and past participle: plot of age-group averages for gaze fixations from the onset of the 2nd NP until 2100 ms (SVO and OVS sentences with masculine first NP, correct and incorrect), showing percentages of fixations directed at the target picture

200-700

There was a three-way interaction between Image, Age Group and Sentence Type. Separate analysis per Age Group revealed for the adults a main effect of Image and a two-way interaction between Image and Sentence Type. Further analysis of the interaction returned a significant main effect for Image during both SVO and OVS sentences. The interaction reflects higher target fixations during OVS rather than SVO sentences. On the other hand, the 7-year-olds showed only a main effect of Image.

700-1400

The three-way interaction retains significance. The adults displayed the same effects as in the previous part of the segment. Again we found a two-way interaction

between Image and Sentence Type and a main effect of Image in both conditions, due to higher number of gazes directed at the target picture during OVS rather than SVO sentences. On the other hand, the 7-year-olds displayed a main effect of Image and a two-way interaction between Image and Sentence Type at this point. Furthermore, there were main effects of Image during both SVO and OVS sentences. The interaction reflects the increasing number of fixations to the target picture during SVO, whereas during OVS sentences target fixations started to decrease.

1400-2100

The same effects as in the previous part (700-1400) of segment 3 were found.

Discussion: Time Segment 3

With the onset of the second NP, the interaction found in the analysis of the adults and all three parts reveal that while they were at ceiling in the OVS condition, they were looking less at the target picture during SVO sentences. A similar effect during canonical sentences was found in the first two experiments of this dissertation with passive sentences. While we do not know the origin of this pattern, we speculate that „boredom“ in the case of canonical sentences might be a plausible explanation for the finding.

The fact that we found a three-way interaction with the factor Age Group in the analysis with all factors indicates a different cue weighting between the adults and the 7-year-olds. This effect is confirmed by the absence of a two-way interaction between Sentence Type and Image in the first part of the time segment (as it is the case for the adults) and the only presence of a main effect of Image. This demonstrates that the 7-year-olds were exploiting the accusative marker at this time point in the sentence, thus being on the right track with both SVO and OVS sentences. However, this correct and increasing pattern during OVS sentences already ends during the second part of the segment and in the last part target fixations goes ahead, decreasing to chance level, as shown by the significant interaction in both parts. It is noteworthy that the interaction revealed the opposite pattern from the adults, reflecting the higher target fixations during SVO than OVS sentences. This suggests overall that children initially exploited the cue, although this reliance is shown to be very brief.

Summary

The adults remained sensitive from the start of the sentence to the disambiguating nominative and accusative cues, and with the onset of the auxiliary, they started to look less at the target picture during SVO sentences, a finding that we interpreted as a "boredom" effect. On the other hand, target fixations during OVS sentences progressively increased and ended up at ceiling level by the end of the sentence, thus fully matching the adult off-line performance. On the other hand, though children also revealed a reaction to the accusative cue, in comparison to the adults, it was weaker, lasted for a shorter period of time – as they subsequently reverted to their previous incorrect analysis – and adopted later. Importantly for our analysis, the on-line data revealed that the children did make use of the accusative-marked *den*, thus suggesting that they have linguistic knowledge of the structure, a finding that we would have otherwise ignored considering the off-line chance results alone. The worse off-line than on-line picture emerged by the data confirms previous studies showing that children perform better during their on-line performance as they are not asked to explicitly provide any interpretation of the sentence they have heard.

4.6.3 Experiment 3.2: study with temporarily ambiguous SVO and OVS sentences

4.6.3.1 Participants

Thirteen monolingual German-speaking adults (8 female and 5 male) and ten seven-year-old monolingual German-speaking children (8 female and 2 male; age range = 6,7-7,8; mean age 7,4 years; SD = .3804) participated. Adults were university students, whereas children attended the first year of the German primary school system. For their participation in the study, participants received course credits and a child-friendly certificate, respectively.

4.6.3.2 Materials

Like in experiment 3.1, sixteen experimental sentences were created. Each sentence was presented in either the SVO or OVS condition (within-subject experimental condition) and was paired with a picture (Figure 17).

(5) *Die Mutter hat am Abend den Vater sehr lange geküsst*
The mother-FEMSGNOM/AMB has-AUX in the evening-ADV the father-MASCSGACC/UNAMB very long-ADV kissed-PPART

(6) *Die Mutter hat am Abend der Vater sehr lange geküsst*
The mother-FEMSGACC/AMB has-AUX in the evening-ADV the father-MASCSGNOM/UNAMB very long-ADV kissed-PPART

The first NP in both sentence types has feminine gender, which leads to ambiguous nominative and accusative case-markers. The second NP has masculine gender, which is unambiguous between nominative and accusative and disambiguates the sentence as SVO and OVS. The pairs of agent/patient and the verbs were the same as in experiment 3.1 and the same for the warm-up and filler items.

4.6.3.3 Procedure

The procedure was identical to experiment 3.1.

4.6.3.4 Coding

For the analysis of the eye-tracking data, the experimental sentences were divided into three main time segments.

	Time Segment 1	**Time Segment 2**	**Time Segment 3**		
	Sentence Onset 200+500ms (1stNP)	**Onset AUX 200-900ms**	**Onset 2nd NP + PPART 200-700ms**	**700-1400ms**	**1400-2100ms**
SVO	Die Mutter	hat am Abend	den Vater sehr lange geküsst		
OVS	Die Mutter	hat am Abend	der Vater sehr lange geküsst		

Table 6: Time segments (Experiment 3.2 of study 3), selected on the basis of cue onset

Time segment 1 includes the first ambiguous morphosyntactic cue, the first feminine NP, which is identical in both conditions. The second time segment corresponds to the onset of the auxiliary and the adverb, which do not provide any cues for disambiguation between a SVO or OVS sentence interpretation. Finally, time segment 3 includes the disambiguating cue, the masculine NP. Again, like in experiment 3.1, time segment 3 was divided into three parts to reach a more detailed analysis. Segment onsets were calculated on a sentence-by-sentence basis. The length of each time segment was established taking into consideration the average, earliest and latest onset of the subsequent cues in the next time segment.[34] The remaining data analysis was identical to experiment 3.1.

[34] Earliest, mean and latest time of, respectively, Onset 1 (auxiliary), 376, 560, 695 ms; Onset 2 (2nd NP), 888, 1077, 1367 ms; measured from the previous onset.

4.6.3.5 Results

4.6.3.5.1 Accuracy

Adults were at ceiling with SVO sentences, at 100%, and performed slightly above chance in the OVS condition, at 58%.[35] The 7-year-olds were accurate in the SVO condition, at 90%, and misinterpreted almost all OVS sentences with 9% accurate responses.[36] Statistically, we found a main effect of Age (estimate = 5.4421, std. = 0.9977, z = 5.455, p = 0) and no significant interaction between Age and Sentence Type. These findings reflect the difference in accuracy scores for both SVO and OVS sentences.

4.6.3.5.2 Eye movement data

The same statistical analysis was conducted as in experiment 3.1. Figure 22 shows the percentage of fixations on the target picture for the full time-course of the experimental items. Descriptively speaking, despite very pronounced differences in the robustness of the strategies, both groups display the same mirror image after 860ms, indicating the use of an "agent-first strategy" in both groups. Importantly, with the onset of the second disambiguating NPs in both conditions, target fixations can be observed to increase in both groups, indicating the on-line use of the cues. During OVS sentences, the increase is much stronger for the adults as opposed to the children.

[35] Seven trials overall (6.7 %) were excluded from the analysis (two trials, 1.9% in the SVO condition and five trials, 4.8% in the OVS condition) because participants elicited no answer.

[36] Nine trials overall were excluded from the analysis (one trial, 1.3% in the SVO condition and three trials, 3.8% in the OVS condition elicited no answer whereas two trials, 2.5% in the SVO condition and three trials, 3.8% in the OVS condition were classified as "trials skipped", because no eye-gaze was detected, probably because participants pressed the key for too long and the program moved on to the next trial).

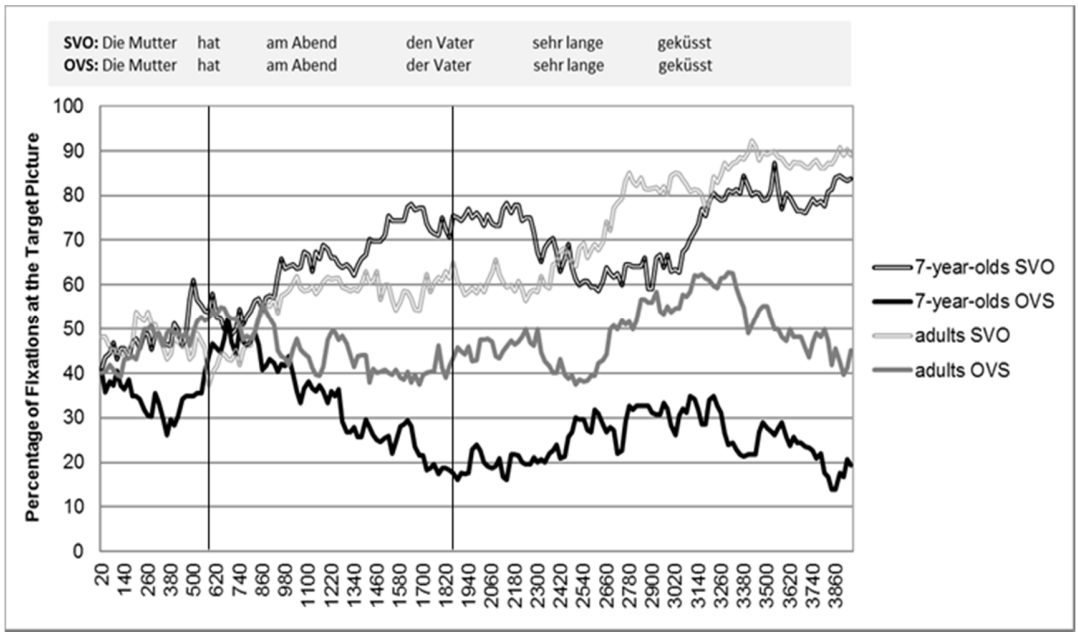


Figure 22: Plot of age-group averages for gaze fixations from start to finish of trial (SVO and OVS sentences with feminine first NP, correct and incorrect trials), showing percentages of fixations directed at the target picture

Time Segment 1: ambiguous feminine first NP (SVO/OVS, die Mutter)

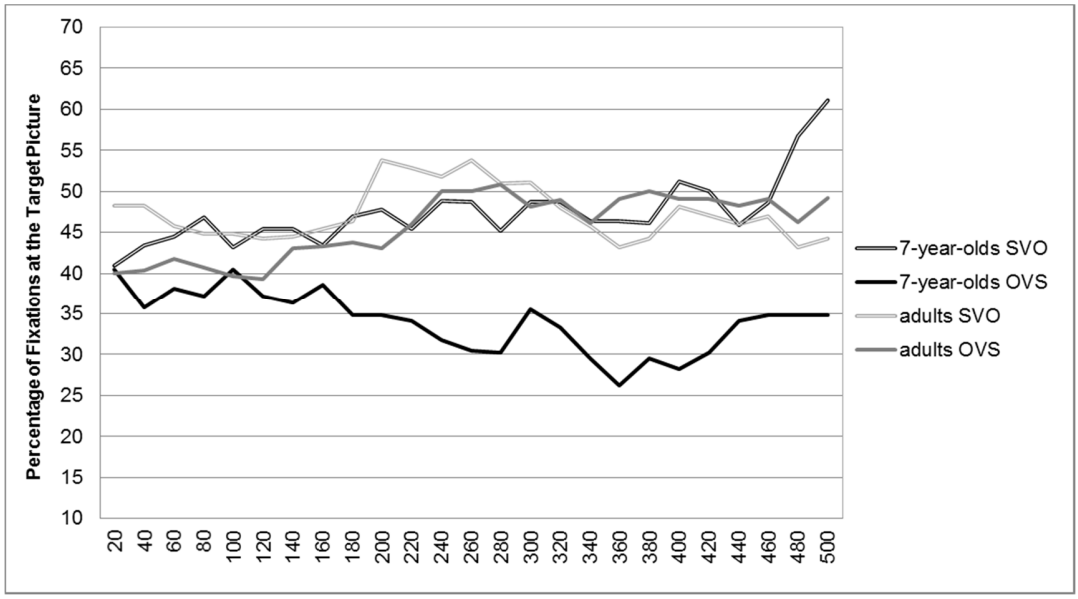


Figure 23: Gaze fixation during the ambiguous first NP: plot of age-group averages for gaze fixations from start of trial (SVO and OVS sentences with feminine first NP, correct and incorrect trials) until 500 ms, showing percentages of fixations directed at the target picture

We found a three-way interaction between Image, Age Group and Sentence Type. To unpack this interaction, we subsequently analysed the number of fixations for each

age group. No effects reached significance in the analysis of the adults, whereas the 7-year-olds revealed a main effect of Image and a two-way interaction of Image and Sentence Type. Further analysis of the interaction divided per sentence type revealed a significant main effect of Image during OVS sentences only. The effects found in the analysis of the 7-year-olds are reflected in their tendency to look more at the competitor picture in both conditions and more strongly in the OVS.

Discussion: Time Segment 1

This main effect of the 7-year-olds during OVS sentences only is surprising as we would have not expected any differences between the two conditions including the same ambiguous feminine NP. Moreover, as sentences were cross-spliced, there were no intonational cues at disposal for disambiguation. If the children had made use of an "agent-first strategy", this would have led to an effect of Image in the SVO condition, which we did not find.

Time Segment 2: auxiliary (SVO/OVS, hat)

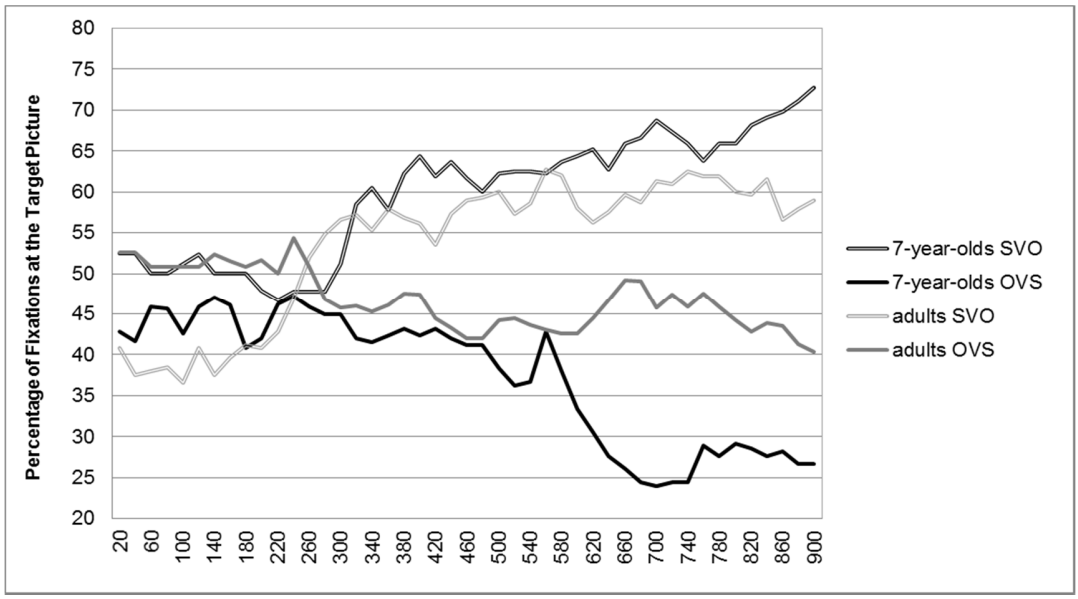


Figure 24: Gaze fixation during the auxiliary and the adverb: plot of age-group averages for gaze fixations from the onset of auxiliaries until 900 ms (SVO and OVS sentences with feminine first NP, correct and incorrect trials), showing percentages of fixations directed at the target picture

There was a three-way interaction between Image, Age Group and Sentence Type. Separate analysis divided per Age Group revealed a two-way interaction between Image and Sentence Type in both groups. This is reflected in the greater number of target fixations during SVO rather than OVS sentences. In addition, we only found a significant main effect of Image in the separate analysis of the interaction per sentence type for the 7-year-olds, indicating the more pronounced pattern.

Discussion: Time Segment 2

In this time window, the picture is much clearer, showing that after the onset of the auxiliary *hat*, both groups interpreted the first ambiguous feminine NP as it were the agent, thus being on the wrong track during OVS sentences. In addition, we can see that the 7-year-olds adopted this strategy more strongly than the adults, as demonstrated by the main effects of Image in both conditions and descriptively by a difference of 10% between children and adults´ target fixations.

Time Segment 3: 2nd NP (SVO, den Vater; OVS, der Vater) + past participle

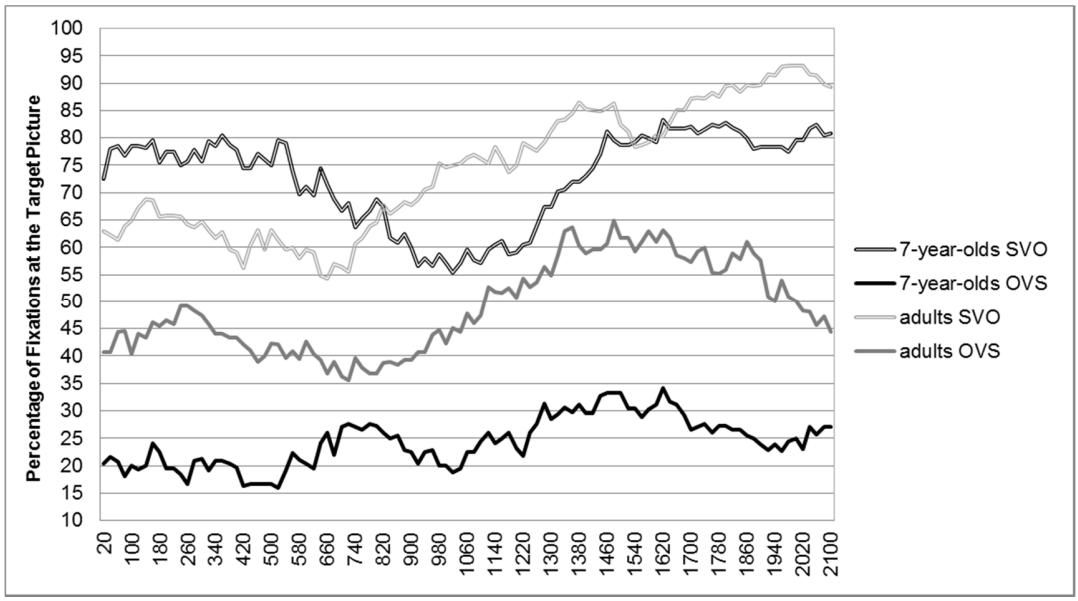


Figure 25: Gaze fixation during the disambiguating 2nd NP, adverb and past participle: plot of age-group averages for gaze fixations from the onset of the 2nd NP until 2100 ms (SVO and OVS sentences with feminine first NP, correct and incorrect trials), showing percentages of fixations directed at the target picture

200-700

There was a three-way interaction between Image, Age Group and Sentence Type. Separate analysis divided per Age Group revealed a two-way interaction between Image and Sentence Type in both groups. Further analysis of the interaction per Sentence Type displayed a significant main effect of Image in both groups. Like in the previous time segment, the interaction reflects more fixations at the target picture during SVO and more at the competitor during OVS.

700-1400

The same effects as in the previous part (200-700) of segment 3 were found.

1400-2100

The same effects as in the first part (200-700) of segment 3 were found.

Discussion: Time Segment 3

Statistically, we found the same effects in all three parts of segment 3. Both groups showed continued use of the "agent-first strategy", thus being on the right track during SVO sentences and on the wrong track during OVS sentences. Even if we could not show this statistically, as the main effect of Image was significant in the separate analysis of the interaction in both groups, Figure 25 shows that this strategy was more pronounced in the children rather than the adults. Moreover, descriptively, participants made use of the accusative-marked NP in the SVO condition, which works for both groups as a confirmation of the "agent-first strategy". On the other hand, the onset of the nominative-marked NP triggered a minimal reaction in the children, who continued with the wrong "agent-first strategy", whereas the adults were more sensitive to this cue, without reaching ceiling level yet, albeit being slightly above the 60% line. The fact that target fixations of the adults in this condition decreased at the end might be interpreted as a checking behaviour. It might be the case that adults found the sentences so odd that they were not completely convinced of the new OVS interpretation and thus checked again the incongruent picture, the one in which the first NP is the subject/agent.

Summary

Both groups interpreted temporarily ambiguous OVS sentences as if they were canonical sentences. However, the use of the "agent-first strategy" was more pronounced among the children than among the adults. This shows that in the absence of a clear disambiguating marker both groups made use of this strategy but the adults were more cautious in completely relying on it. With the onset of the disambiguating cue, the second NP, the adults reacted to the disambiguating nominative-marked cue in almost 50% of the cases, whereas the children revealed a minimal reaction to it. Between the on-line and off-line data, the adults revealed almost identical performance, whereas the children were better on-line than off-line, with 30% of target fixations vs. 9% correct responses.

4.7 General discussion

In order to discuss the findings of the two experiments, we will divide this discussion into sections according to the three main research questions that we addressed in the introduction, focusing on: (1) participants' off-line performance; (2) participants' on-line use of the morphosyntactic cues; and (3) differences between their on-line and off-line performances. The questions are answered separately for experiments 3.1 and 3.2, respectively, for SVO and OVS unambiguous sentences and SVO and OVS temporarily ambiguous sentences.

Off-line performance

Unambiguous sentences (Experiment 3.1)

In the first experiment, the adults revealed no accuracy differences in the off-line task during SVO and OVS sentences. By contrast, the children performed worse with OVS sentences, revealing a mere chance performance. This chance performance is in line with previous off-line studies conducted with 7-year-olds (Biran & Ruigendijk, 2015; Dittmar et al., 2008; Gamper, 2016) suggesting that children at that age have not yet abandoned the use of the "agent-first strategy" and still rely on it when case-marking is in competition, pointing towards another interpretation of the first NP.

Temporarily ambiguous sentences (Experiment 3.2)

Both groups were very low in comprehension of OVS in comparison to SVO sentences. The finding that this type of OVS sentence was much more difficult than the one in experiment 3.1 confirms previous off-line studies with children and adults (Biran & Ruigendijk, 2015; Ferreira & Henderson, 1991; Friederici et al., 1998; Mills, 1977; Schaner-Wolles, 1989). The longer the ambiguous region, the more difficult it is for comprehenders to suppress initial sentence commitment in favour of a new cue pointing to a different sentence interpretation. Moreover, another explanation that does not exclude the previous one might be the notion that the reliance on the "agent-first strategy" is so firmly established at that time point of the sentence that the nominative cue on the second NP is ignored.

On-line use of the morphosyntactic cues

Unambiguous sentences (Experiment 3.1)

The adults revealed an immediate reaction to the first accusative NP. A slight "agent-first strategy" was also detected during the early part of the sentence, although it was minimal and immediately overcome by the increased number of target fixations triggered by the masculine accusative-marked article. No great reanalysis costs for the adults can be observed, as the "agent-first strategy" was minimal and they were immediately on the right track. This pattern is also in line with that found in Wendt et al. (2014) with German adults.

By contrast, the children did not show any initial increase in gaze fixations to the target picture during OVS sentences similar to the one detected in the analysis of the adults. Such an increase was detected in the children, but it occurred later, after the onset of the second NP, and subsequently almost reached the level seen in the adults. However, unlike the adults, target fixations by the children did not remain at this high level, but rather returned to the initial chance level. It is interesting that children's target fixations during OVS sentences never dropped below the 50% line, suggesting that children did not adopt a proper "agent-first strategy". Since the two previous studies in this volume conducted with 7-year-old children revealed the use of an "agent-first strategy", it may be that even if the children reacted to the unambiguous accusative article *den* later in the sentence, they were actually sensitive to it from the start and this slight initial sensitivity blocked the "agent-first strategy", explaining why fixations during OVS sentences never fell below chance. Nevertheless, a proper integration of the accusative case-marking cannot be observed until the last segment. It might be the case that in comparison to the adults children prefer to wait until the second NP, the subject, which further disambiguates the sentence as an OVS before interpreting the first NP as the direct object and patient of the action. On the other hand, the adults reveal themselves to be more sure than the children that the marking *den* on the first NP is a signal marking objects and patients, and for this reason their reaction is more immediate.

These findings enlarge our knowledge on the adult vs. the child processing system with respect to three perspectives:

Weight of the "agent-first strategy" and case-marking: The fact that target fixations at their maximum point were still higher for adults than children suggests that the unambiguous masculine accusative-marked cue *den* might be a less reliable cue for the children than it is for the adults. Previous studies documented that children perform worse than adults with non-canonical sentences (Dittmar et al., 2008; Gamper, 2016; Roesch & Chondrogianni, 2014) and even if at age 7 the accusative case-marking has been acquired (Köpcke, 2003), it represents a hurdle for the children if in competition with the canonical word order expectation. Children assign less weight to the case-marking cue when it conflicts with the canonical word order and/or more strongly rely on the "agent-first strategy", which has been calculated to be highly available in German. This would be in line with the finding that for children *validity* is constituted differently, as the feature of *availability* counts more than *reliability* (Dittmar et al., 2008).

This different weighting between the two groups also explains the later reaction to the accusative-marked NP by the children because the competition between the "agent-first strategy" and case-marking is more marked in the children than in the adults. This suggests that the speed at which they integrate cues/expectations is affected by the values that the children assign to them. The different value assigned to them is in close relation with the children's exposure to the language. In other words, the fact that children assign less weight to case-marking and over-rely on the "agent-first strategy" might be determined by their relatively short experience of dealing with them in competition. With this interpretation, we can argue that the slower cue integration of the children (see also Sekerina et al., 2004) need not be considered a general assumption to be applied to every type of cue or expectation, as it rather seems to depend on the type of cue/expectation and on the population under investigation.

Working memory: According to Bahlmann et al. (2007), the difficulty with this first type of sentences is a reflection of the comprehender's working memory system. The challenge for the comprehender while processing unambiguous OVS sentences is to store the unexpected cue on the first NP and wait for the second NP which is in line with the interpretation of the first NP as object. At the same time the more frequent "agent-first strategy" must be kept inhibited. We would argue that an additional

difficulty is implied by having to retain the OVS analysis all the way to the end of the sentence.

The current study demonstrates that while adults succeeded in doing so and were able to interpret OVS sentences correctly immediately after the onset of the object, the first NP, children waited until the subject, the second NP, as if they needed to test whether the second NP was indeed in line with a possible interpretation of the first NP as object. Moreover, differently from the adults, children were unable to hold the correct non-canonical analysis in working memory, as shown by their decrease in target fixations, and return to the original analysis after having interpreted the cue correctly with the onset of the second NP. This finding suggests that due to their less-developed working memory faculties, children have difficulty retaining the new interpretation until the end of the sentence and in almost half of the cases the initial canonical interpretation gains the upper hand, leading to the final incorrect sentence interpretation.

Temporarily ambiguous sentences (Experiment 3.2)

Both groups adopted an "agent-first strategy" starting from the auxiliary and lasting until the onset of the disambiguating cue on the second NP. This strategy was differently weighted by the two groups, with the adults making a weaker use of it than the children. With the onset of the disambiguating cue, the adults revealed an attempt to revise the initial wrong commitment (albeit not overcoming the chance line), whereas revision on the part of the children was negligible. In comparison to the OVS sentences in experiment 3.1, it is clear that both groups had trouble integrating the new conflicting cue in this condition. This finding confirms previous studies showing that the longer the ambiguous region, the more difficult it is for the processing system to suppress the initial wrong commitment and revise the sentence to integrate the new cue (Bader & Meng, 2000; Ferreira & Henderson, 1991; Mills, 1977).

The almost absent reaction of the 7-year-olds might be explained by two factors:

Inhibitory control: Children's less-developed inhibitory control might explain their difficulty in suppressing a strategy to which they have committed themselves when conflicting cues emerge later in the sentence. Previous studies have shown this with 5-year-olds (Choi & Trueswell, 2010; Trueswell et al., 1999). It might be the case that at age 7, cognitive factors still have an influence on their parsing, as cognitive faculties continue to develop until adolescence. Moreover, the cue that children were being expected to abandon in the current study is the "agent-first strategy", upon which children rely heavily because of its high frequency (Chan et al., 2009; Dittmar et al., 2008). This might indicate that the lack of revision was due to difficulties in not only revising initial commitment but also abandoning a heavily relied-upon commitment.

Linguistic knowledge: The cue itself, the masculine nominative article *der* on the second NP, may have been overlooked by the younger learners, who have less experience with this marked NP in final position due to their limited exposure to the language, i.e., with temporarily ambiguous OVS sentences (as also suggested by Mills, 1977). Crucially, the fact that even the adults were not very successful in revising this strategy suggests that the cue in that position and in the absence of a pragmatically-driven and/or motivated context was overall particularly difficult even for an expert parser. In Knoeferle et al. (2005), adults showed more success in reacting to the cues appearing later in the sentence than the adults in the present experiment. However, in the study, adults were also helped by the visual context, which allowed them to disambiguate the OVS sentences through the lexical verb represented in the picture and thus exclude the other possible canonical incorrect interpretation of the sentence.

Differences between on-line and off-line performance

Unambiguous sentences (Experiment 3.1)

If we consider children's target fixations at the end of the sentences and their accuracy scores during OVS sentences, no differences are detected, as in both cases

performance was slightly above chance (55%). However, it is important to note what we see happening in the last segment. Though the 7-year-olds succeeded in recognising and integrating in their sentence interpretation the unambiguous accusative-marked NP, shortly before executing the off-line task, they returned to the original interpretation, as if resources to continue maintaining the new OVS analysis in memory were exhausted. Moreover, another explanation for the final drop in target eye movements might lie in the visual context. Recall that participants were presented with two pictures in which the two protagonists were engaged in the same action and differed only in their reversal of thematic roles. This resulted in two highly similar pictures. Therefore, it might be the case that the visual setting itself was confusing for the younger learners, who had to not only pay attention to the sentence, but also sort out a challenging visual setting. For further studies, rather than presenting participants with a depiction of the protagonists already engaged in the action (once correctly and once with reversed roles), it might be less confusing to present participants with a wh-question, either in the canonical word order, such as *Welcher Vater*-NOM *küsst die Mutter*? 'Which father kisses the mother?' or in the non canonical *Welchen Vater-ACC küsst die Mutter*? 'Which father does the mother kiss?'. The visual prompt for these type of questions would show the mother in the middle of the picture with fathers on either side. The father on the left would be making a kiss gesture towards the mother and thus potentially play the role of agent, while the mother in the middle would be making a kiss gesture towards the father on the right, making her the agent and the father on the right the patient.

Temporarily ambiguous sentences (Experiment 3.2)

Children performed very weakly in both the off-line and on-line tasks, with 9% and 27%, respectively. The 18% difference indicates an advantage during on-line parsing, although even in the on-line task revision of the initial commitment is almost absent. The adults were similar in both their on-line and off-line performance, indicating that even mature speakers had trouble integrating late-occurring cues, but when they did, they were able to maintain this interpretation.

4.8 Conclusion

In the current study, we replicate the finding that non-canonical sentences such as OVS sentences are more challenging than canonical SVO sentences for both children and adults. By testing participants on unambiguous and temporarily ambiguous OVS sentences we were able to demonstrate how difficult it is for both groups and especially for the younger learners when the ambiguous region is prolonged, such as in temporarily ambiguous OVS sentences (experiment 3.2).

The monitoring of participants' eye gazes provided interesting and new insights into their processing. First, it informed us about children's knowledge of case-marking and showed that children react to the accusative case-marking in initial position less quickly and less strongly than adults. The use of the "agent-first strategy" is more pronounced in children than in adults, while the opposite is true for case-marking. We interpreted this difference as the result of less exposure to the language and thus experience with the canonical word order and case-marking in competition. Moreover, we demonstrated that children adopt a strategy of "waiting and checking" before starting to interpret OVS sentences as such, a strategy that did not emerge in the adult analysis. On the other hand, when the disambiguating cue occurs later in the sentence, children do not react to the new cue and persist in processing the sentence according to the "agent-first strategy". In this case, we found that, besides the fact that the "agent-first strategy" is a strategy upon which they strongly rely, the length of reliance on this strategy due to the late disambiguation point might be responsible for the children's low on-line and off-line performance. The low off-line and on-line scores of the adults show that adults are also highly challenged by the revision process. It should be noted again that OVS sentences in German are mostly pragmatically marked and contextually motivated, whereas in this study no intonational cue was provided and the sentences were presented in isolation.

Second, the on-line data gives us useful information about why off-line performance is lower for these sentences. In experiment 3.1, we were able to show how their less-developed cognitive functions might hinder children in keeping new, less frequent interpretation until the end of the sentence. In experiment 3.2, we provided evidence that a lower inhibitory control might affect children's capacity to

suppress initial interpretations that are potentially valid. These findings together suggest that OVS sentences are to differing degrees particularly challenging because of the cognitive competences they require for their processing.

For future research, it would be of interest to collect on-line data on the processing of OVS sentences in which were also manipulated other cues such as intonation and/or animacy to ascertain whether children consequently reveal a more adult-like on-line behaviour.

Overall, this study shows that through combining on-line and off-line methods we can gain new insights into the reason for poor off-line performance and show how much knowledge children do in fact have at age 7.

5 The processing of German OVS sentences in monolingual and second language children

5.1 Introduction

Languages vary in how they use word order and inflections to assign agent and patient relation in transitive sentences. An early study by Slobin and Bever (1982) involving English, Italian, Serbo-Croatian and Turkish children provided evidence that during comprehension the children belonging to the first three groups relied strongly on the "agent-first strategy", according to which the first NP is the subject of the sentence and agent of the action. On the other hand, Turkish children were more sensitive to inflection independently of word order. The authors explained these findings by claiming that language is interpreted according to language-specific schemas, thus arguing against a universal default strategy in language comprehension based on a fixed word order (see, e.g., Bever, 1970). This study has given rise to a set of studies investigating other languages, including, among others, German, a language that "is neither of a clear positional type nor of an easy to grasp morphological type" (Schaner-Wolles, 1989:133; see also Biran & Ruigendijk, 2015; Dittmar et al., 2008; Lindner, 2003; Mills, 1977; Roesch & Chondrogianni, 2014). German is indeed a free word order language, like Turkish, in which grammatical relations are determined by morphosyntactic means, among them case-marking. Its canonical agent-before-patient ordering is nevertheless more frequent than the word order in which the object/patient occupies the foreground position (Dittmar et al., 2008). Furthermore, relative to Turkish or other free word order languages the German case-marking system is less transparent due to a certain amount of inflectional syncretism. The task of the German native speaker learning his/her own language or the learner of German as a L2 is thus to discover the different case-marking forms, find out the function(s) they are mapped onto and learn to rely on them when they do not align with the canonical word order, according to which the first NP of a sentence corresponds to the subject/agent.

The purpose of the abovementioned studies was to determine when L1 children start to rely on case-marking in German when it conflicts with the canonical word

order. The German structure in which this competition occurs is OVS sentences. A common finding among the studies is that the task of the listener is more difficult when they are confronted with these sentences, as also shown by previous studies with adults (Hemforth et al., 1993; Konieczny 1996; Schlesewsky et al., 2000).

In the field of child L2 acquisition research, most of the studies on case-marking have concentrated on examining how L2 learners with different L1s acquire the system (untutored L2 acquisition studies: e.g., Bast, 2003; Jeuk, 2006; Marouani, 2006; Wegener, 1995; tutored L2 acquisition studies: Baten, 2013; Diehl, Christen, & Leuenberger, 2000). However, only a few off-line studies have investigated participants' final comprehension of OVS sentences in order to determine whether listeners rely more on the canonical word order, that is the "agent-first strategy" or case-marking (wh-questions, Roesch & Chondrogianni, 2014; declarative sentences, Gamper, 2016). Furthermore, still fewer studies have investigated the real-time exploitation of the "agent-first strategy" and case-marking during comprehension by learners of German as a L2 (Chondrogianni & Marinis, 2012; Marinis, 2007). These few studies have been conducted with learners of English as a L2, examined morphosyntactic cues other than case-marking in competition with the "agent-first strategy" and also employed other methods. For this reason, the question of how learners of German as a L2 exploit the "agent-first strategy" and case-marking during comprehension when the canonical expectation and the case-marking cue compete with each other has not been yet addressed. Crucially, the investigation of real-time comprehension (on-line processing) is of particular interest as it enables researchers on language acquisition to observe in detail how L2 learners construct their sentence representation and whether and how this process differs from that seen in monolingual children. Importantly, while it may be true that several studies have revealed that case is one of the grammatical categories that is very challenging for children acquiring German, both in first and second language acquisition (see, among others, Clahsen, 1984, Köpcke, 2003 and Tracy, 1986 for L1 children; Jeuk, 2013; Kaltenbacher & Klages, 2006; Marouani, 2006; Wegener, 1995 for L2 children), there is no research to date on how learners exploit case-marking in real time when it is in competition with the canonical word order.

To answer this question, in the present study we combined both on-line and off-line methods. Participants' eye gaze movements directed at two pictures were monitored (to give us the on-line data) as they listened to a sentence and then they were asked to select which of the two pictures corresponded to the sentence they had heard (giving us the off-line data). Participants were 7-year-old monolingual German children and Turkish-German children, with an age of onset of L2-acquisiton of 3-4 years. They were tested in two experiments conducted with two types of SVO and OVS sentences, differing in their point of disambiguation. Experiment 4.1 included sentences that were early-disambiguated, that is, during the first NP, which we will refer to as "unambiguous sentences", and experiment 4.2 comprised sentences that were late-disambiguated, that is, during the second NP, which we will refer to as "temporarily ambiguous sentences". The chapter is structured as follows. First, we review studies on the acquisition of case-marking in German by L1 and L2 children. We then present the few off-line studies that have looked at how L1 and L2 learners of German resolve the conflict between the expectation of the canonical word order and conflicting case-marking during unambiguous and temporarily ambiguous OVS sentences. We also review processing studies conducted with L1 and L2 learners. Next, after detailing the procedure and results obtained in both of our own experiments, we discuss our findings, focusing on the parsing mechanisms of L1 and L2 children learning the L2 starting from age 3 and 4.

5.2 Acquisition of case-marking

A description of the German case-marking system is provided in the introduction of the dissertation, Table 1 (pag. 10). For the purposes of the present study, it is important to recall that German has a morphological case system comprising four cases, nominative, accusative, dative and genitive. Case is marked on articles, question words and in some cases on the noun itself (e.g., dative plural, genitive singular, as well a special class of nouns, the so-called weak masculine nouns). As can be inferred from Table 1, case-marking changes according to the gender and number of the noun. The system is characterized by a great deal of inflectional syncretism, which results in ambiguities among the different forms and their

functions. Only masculine nouns have a distinct morphology in each of the four cases, whereas feminine and neuter nouns do not present clear information concerning their function. In the current study, we focus on masculine and feminine nouns in the nominative and accusative singular. We made use of the definite articles that mark their case respectively with the forms *der* and *den* for masculine and *die* for feminine, which remains unvaried in these two cases.

Those studies that have investigated the acquisition of the German case-marking system in L1 children (e.g., Clahsen, 1984; Köpcke, 2003; Meisel, 1986; Mills, 1977; Szagun, 2013; Tracy, 1986) and L2 children with different L1s (e.g., Dimroth, 2007; Grießhaber, 2006; Kaltenbacher & Klages, 2006; Wegener, 1995) agree that the acquisition of the case-marking system is a lengthy process, with case being one of the last aspects of the core grammar that children master. In order to correctly mark case, the young learner has to know first and foremost the gender (and number) of the noun, which in German is one of the most challenging tasks because no clear relationship between the form of the noun and its gender is necessarily available (see Binanzer, 2017, for a recent work on L1 and L2 child gender acquisition). This cumulative task in which the learner has to unify case-marking, gender and number information in order to correctly mark nouns is further complicated by the variety of allomorphs and inflectional syncretism present in German, which makes the various form-function mappings overall less transparent.

The abovementioned studies on German case-marking acquisition show that both L1 and L2 children acquire first the nominative, then the accusative and finally the dative case-marking. These first markings of accusative are observed at age 3 in L1 acquisition, whereas they occur in L2 acquisition after less than a year of exposure. Important for the present study is the finding that L2 children seem to acquire a case-marking system before they master gender. More precisely, in the early stages of case-marking acquisition, *der* and *die* have already been acquired and are used to mark the nominative independently of the gender of the referring noun, whereas all objects are initially marked with the masculine accusative article *den* (Dimroth, 2007; Jeuk, 2013; Kaltenbacher & Klages, 2006; Wegener, 1995).

5.3 Off-line comprehension studies with OVS sentences in monolingual and second language children

In the current study we deal with two types of OVS sentences in which the canonical order of thematic roles, agent-action-patient competes with case-marking, unambiguous OVS sentences (1), in which the first masculine NP is unambiguously marked as direct object and patient of the action, and temporarily ambiguous OVS sentences (2), in which case-marking on the first NP does not differ between the nominative and accusative, such as in the case of feminine and neuter NPs.[37] In these sentences, the second masculine NP is unambiguously nominative-marked so the ambiguity is resolved by the end of the utterance, unlike what we see in fully ambiguous OVS sentences including for instance two feminine NPs (Die Katze-FEMSG/AMB sieht die Maus-FEMSGAMB, 'the cat sees the mouse').

(1) Den Opa hat die Oma geküsst
MASCSGACC/UNAMB + AUX + FEMSGNOM/AMB + LEXV
Object/Patient + Subject/Agent + Verb/Action

(2) Die Oma hat der Opa geküsst
FEMSGACC/AMB + AUX + MASCSGNOM/UNAMB+ LEXV
Object/Patient + Subject/Agent + Verb/Action

5.3.1 Unambiguous OVS sentences

Monolingual children

Despite the fact that the abovementioned findings reveal that L1 children produce accusative case-marking early on, the ability to use case-marking when it points to a different sentence interpretation than the canonical surface word order seems to develop only between the age of 5 and 7 (Biran & Ruigendijk, 2015; Dittmar et al., 2008; Lindner, 2003; Mills, 1977; Roesch & Chondrogianni, 2014; Schaner-Wolles, 1989; Schipke, Knoll, Friederici, & Oberecker, 2012). The question as to which cues

[37] In the present study we focus exclusively on the masculine and feminine gender.

or strategies – whether morphological (case-marking, subject-verb agreement), syntactic (word order) or semantic (animacy) – learners use to assign thematic roles has been extensively investigated within the L1 acquisition literature in the framework of the *Competition Model* (henceforth CM; Bates & MacWhinney, 1987, 1989) and in an earlier similar work (Slobin & Bever, 1982). The purpose of the CM was to predict language-specific strategies on the basis of how frequently a cue occurs in the input (*cue availability*), how reliably it signals a function (*cue reliability*) and how difficult it is to process (*cue cost*). Furthermore, the CM predicts that listeners should have less difficulty understanding those sentences in which cues converge and thus point to the same interpretation (*coalitions-as-prototypes model*) than those in which cues are in competition, that is, pointing to different sentence interpretations. In the latter case, the CM assumes that children will orient themselves to the cues that are the most *valid* in the adult language (calculated as the result of their *availability* and *reliability*). According to a corpus analysis in which German child-directed speech was investigated, case-marking is a more reliable cue than the "agent-first strategy" (Dittmar et al., 2008). [38] The assumption of the CM according to which children rely at first on the most valid cue, namely case-marking, is not supported by the findings of the few studies investigating children's comprehension of OVS sentences in German. In a pointing task, Dittmar et al. (2008) found that in the conflict condition (*Den Tiger*-MASCSGACC *wieft der Bär*-MASCSGNOM 'The tiger-ACC weefs the bear-NOM', where *wiefen*/weef is a nonsense word) 4-year-olds interpreted most of the sentences by applying an "agent-first strategy", that is, by interpreting the first NP as the agent of the action (35% correct responses), mostly ignoring case-marking; later, at age 7, they were shown to rely more on case-marking than on the "agent-first strategy" (69% correct responses). Biran and Ruigendijk (2015) reported a similar pattern, showing that at age 6, children still performed around chance, thus not showing a clear preference for either the "agent-first strategy" or case-marking (see also Schipke et al., 2012). Other studies, however, report that a stronger reliance on case-marking compared to the "agent-first strategy"

[38] In the framework of the *Competition Model*, what we refer to as the "agent-first strategy" is a cue that they refer to as "word order". In our conceptualisation, however, the "agent-first strategy" is not a cue but rather an interpretation preference, since one can have this strategy in mind even before the sentence starts in the absence of any cues.

can already be observed at age 5 (Lindner, 2003; Roesch & Chondrogianni, 2014; Schaner-Wolles, 1989). However, in the Schaner-Wolles (1989) study, the child subjects may have been aided by the fact that real and not nonsense verbs were used, contrary to the methodology applied in Dittmar et al. (2008). By the same token, in Lindner (2003) case-marking was confounded with a further cue, animacy, and in Roesch & Chondrogianni (2014) children were tested with object-initial questions and not object-initial declarative sentences, which are less frequent and more pragmatically marked than object-initial questions. Another aspect that is considered in the CM is *cue cost*. Slobin (1982) proposes that young children tend to react only to the so-called local cues such as case-marking on nouns, while older children are able to take into account presumably more complex overall cues like the "agent-first strategy". Determining which cue 7-year-old L1 children rely on most when the "agent-first strategy" and case-marking are in competition is one of the purposes of the present study.

Second language children

Similarly as in L1 acquisition, in which there is a stage at which nominative markers are overgeneralized, L2 children quickly acquire the accusative case on determiners and in sentence comprehension. Nonetheless, they are still challenged when presented with sentences in which the "agent-first strategy" and case-marking are in competition. Evidence comes from the abovementioned study by Roesch & Chondrogianni (2014), who tested the understanding of object-initial wh-questions in 5-year-old French-German children (age of onset between 3 and 4) and found that L2 children produced less than 40% correct responses (33 %). Gamper (2016) investigated the comprehension of object-initial declarative sentences in the L2 German of 9-year-olds with Russian or Dutch as L1, as well as a group of 9-year-old monolingual Germans. She found that the "agent-first strategy" was still the strategy they used most. Interestingly, there was an effect of the L1, such that the Russian-German children relied on case-marking to a stronger degree than the Dutch-German children and even monolingual German children. This pattern was explained by the relatively high *validity* of case-marking and low *validity* of the "agent-first strategy" in Russian. This finding supports the assumption of the CM that listeners at initial

stages of L2 acquisition transfer the cue *validity* hierarchy of the L1 to the L2, before acquiring the *validity* hierarchy of the L2 (MacWhinney, 2005). For the present study, this finding is of particular relevance as this could lead the L2 German-Turkish learners who participated to be advantaged in processing the German case-marking, since case-marking is a highly *valid* cue in Turkish (more so than in German because it is less ambiguous), while the "agent-first strategy" is not (Erguvanli, 1984).

5.3.2 Temporarily ambiguous OVS sentences

Studies in which children were presented with temporarily ambiguous sentences are rare and agree overall on the fact that these sentences pose a greater challenge than unambiguous OVS sentences. Two of the previously mentioned studies, Biran and Ruigendijk (2015) and Gamper (2016) tested children also with temporarily ambiguous OVS sentences. Biran and Ruigendijk (2015) found that the comprehension of German 6-year-olds was very low in this condition (33% correct; see also Mills, 1977). Gamper (2016) tested 9-year-old German, Dutch-German and Russian-German children with these sentences and found that the performance of all three groups was much worse than with unambiguous sentences. The notion that these sentences pose a greater degree of challenge is also supported by findings from studies with German adults. In chapter 4 of this dissertation we found that adults achieved only slightly above chance results both off-line and on-line. As explained in the previous chapter, in line with previous studies, the hypothesis is confirmed that the longer the ambiguous region of a sentence, the more difficult it is for the parser to reanalyse the sentence, thereby inhibiting the analysis that has been pursued through much of the sentence (Bader & Meng, 2000; Ferreira & Henderson, 1991).

Summary

This review of studies on L1 and L2 learners of German reveals that both groups rely very heavily on the "agent-first strategy" for the assignment of thematic roles during sentence processing. However, those L2 children whose L1 presents different word orders, seem to make a less use of it than the L1 children. Resolving the competition between case-marking and the "agent-first strategy" is a more difficult task for L2

learners than for L1 children and overall more challenging wih temporarily ambiguous than unambiguous OVS sentences.

5.4 On-line processing studies with OVS sentence in monolingual and second language children

5.4.1 Monolingual children

A recent study conducted in the field of neurolinguistics measuring both the accuracy and event-related-potentials (ERP) of L1 German children in response to early disambiguated OVS sentences revealed that at age 6 children interpreted 55% of the sentences correctly, similar to Dittmar et al. (2008) findings (Schipke et al., 2012). Interestingly, ERP measurements revealed that at age 6 children started to process the unambiguous first masculine accusative NP in unambiguous OVS sentences just like the adult control group. This was interpreted as evidence that at age 6 children have recognized the non-canonical syntactic structure (different effects were found in the younger groups); yet, unlike adults, they have difficulty in the syntactic integration of the second NP and ultimate assignment of the correct thematic roles. In other words, these findings demonstrate that 6-year-olds make on-line use of the cues even if this knowledge is not reflected in their final response.

The fact that the investigaton of children's on-line processing points to a better knowledge of cues than what is suggested by the off-line scores also emerges from a study by Adani and Fritzsche (2015). 4-year-old children and an adult control group were tested with subject and object relative clauses, such as *Wo ist die Kuh die*-PRONOUN-FEMSG *den Hund*-MASCSGACC *jagt*? 'Where is the cow who is chasing the dog?' and *Wo ist die Kuh die*- PRONOUN-FEMSG *der Hund*-MASCSGACC *jagt*? 'Where is the cow who the dog is chasing?' in which the relative pronoun is potentially ambiguous because it is feminine, and it is the article of the masculine second NP that disambiguates the sentence. Children were presented with a visual setting in which the masculine second NP (e.g, the dog in the example above) was depicted in the centre while at each side were two identical animals corresponding to the ambiguous referent of the relative clause (e.g., the cow). After a presentation of the animals, with the onset of the relative clause, the three entities started to perform

the action described in the sentence. Participants were instructed to point to the animal that represented the correct answer to the question heard. At the same time, their eye movements were monitored and the proportions of eye gazes directed at the target animal were calculated. In terms of off-line findings, it was found that while adults performed at ceiling in both conditions, children were less accurate during object relative clauses than during subject relative clauses, as expected. However, the on-line findings provided a different picture since a high rate of fixations directed at the target referent in both conditions was detected in both groups, revealing overall a faster increase in target fixations during subject relative than object relative sentences. The difference between the adults and the 4-year-olds concerned the object condition, in which a preference for the canonical interpretation was quickly revised with the onset of the disambiguating cue (*den*) by the adults but lasted longer in the 4-year-olds. The study concludes that the fact that the 4-year-olds were not very successful in the off-line sentence comprehension task did not mean that they were lacking linguistic knowledge of the morphosyntactic cues; rather, it seems that the off-line task alone cannot provide us with a complete picture of the children's knowledge (for a similar picture see also the study on Chinese passive by Huang et al., 2013).

The fact that children´s on-line processing informs us more on children´s linguistic knowledge than the off-line scores has been explained by the authors as well as previous researchers such as Marinis (2010) in terms of limitations in children's executive functions. It is argued that the off-line task itself might imply higher cognitive costs for the participants because in the end they are required to provide a final interpretation of the sentence, whereas while they are actually listening to the sentence (on-line) they are exploiting the cues as they unfold. In particular, less-developed working memory competencies may account for the children's difficulty in maintaining different sentence interpretations simultaneously in their working memory until the end of the sentence. On the other hand, low inhibitory control is thought to make it difficult for children to suppress incorrect interpretations and select the correct one as their final interpretation (Trueswell et al., 1999; Weighall, 2007).

However, it is important to note that the stronger linguistic knowledge emerging from the on-line than the off-line data is not the only possible scenario documented by studies comparing participants' off-line and on-line performance.

In the first two studies reported in this dissertation, in which children were tested on passive sentences, we found that children were off-line correct, but the on-line data revealed differences in the time course of cues´integration, that is how quickly and easily children arrived at the ultimate interpretation. Similar findings were shown by other studies conducted with L1 children and also L2 adults (Hopp, 2010; Stromswold, under review).

No other studies to our knowledge have investigated the on-line processing of temporarily ambiguous OVS sentence in children. Nevertheless, a previous study of Korean 5-year-olds interpreting ambiguous sentences (Choi & Trueswell, 2010) allows us to make tentative predictions about how children will react to temporarily ambiguous OVS sentences in German. Specifically, alongside the finding that children's less developed inhibitory control might prevent them from blocking misinterpretations, the task of revision is even more challenging when the disambiguating cue occurs late in the sentence. In other words, there seems to exist a relationship between children's inhibitory control and the temporal onset of the disambiguating cue. Cues that occur early on in the sentence are more easily processed than cues that occur later because the child has already committed him/herself for a relative long time to an initial analysis and thus needs more resources to abandon it. A relation between cue position in the sentence and success during sentence processing has also emerged in previous studies with adults (Bader & Meng, 2000; Ferreira & Henderson, 1991).

5.4.2 Second language children

Turning to L2 processing, to date only three studies have investigated how L2 children process morphosyntax in real time. The studies were conducted with Turkish-English children during the processing of active vs. passive sentences (Marinis, 2007), pronouns/reflexives (Marinis, 2008) and tense morphemes (Chondrogianni & Marinis, 2012) and provided evidence that L2 learners' reaction

times were qualitatively similar to what was seen in age-matched monolingual English children, that is, they were longer/shorter in both groups in one condition and not in the other. Differences were found at a quantitative level in that the L2 learners revealed overall a slower processing rate than the L1 learners, as seen in longer reaction times. Furthermore, in Marinis (2007) L2 learners were capable of using the active and passive morphosyntactic cues in a similar way as the L1 learners (though a bit slower), but in the final off-line task their performance was worse than the L1 peers. This last finding is compatible with the abovementioned hypothesis concerning the comparison between on-line and off-line performance and showing in this case better on-line than off-line performance by the L2 children. It is of interest to note, however, that executive functions between L1 and L2 age-matched children are assumed to be the same given the same age and consequently biological and cognitive maturity of the two groups, so executive functions may not be the reason for this off-line/on-line asymmetry in the L2 children only. There must be something else going on that causes the L2 children to make less use of this knowledge than the L1 children in the final off-line task. One explanation might be that less proficient language users (proficiency was lower in the L2 children than in the L1 children), despite knowledge of the morphosyntactic cues, in the end tend to rely on simpler and easier strategies, such as in this case the "agent-first strategy".

Summary

Studies conducted with L1 German children and OVS sentences reveal that childrens´s sensitivity to case-marking is stronger in the on-line than in the off-line data. During the off-line task, they experience difficulty in choosing the correct interpretation of the sentence even if on-line they demonstrate that they know the correct analysis. This has been explained in terms of the children's less developed executive functions, making the task of keeping the different interpretations of the sentence in working memory highly challenging with consequent poor results in the off-line task. Furthermore, as shown by the off-line studies, it seems that the position of the disambiguating cue might affect their processing, with more difficulty in integrating disambiguating cues that occur late in the sentence, such as in the case of temporarily ambiguous OVS sentences. As for L2 children, studies investigating

structures other than OVS sentences provide evidence that their processing is highly similar to that seen in L1 children and only slightly slower. Importantly, one study reveals for L2 children better on-line than off-line performance, in contrast to L1 children, for whom the same off-line and on-line results emerge. This finding was interpreted as a preference on the part of less proficient speakers for the easier and less costly strategy during the off-line task, namely the "agent-first strategy".

5.5 Study 4

5.5.1 Overview and research questions

The present study includes two experiments, the first with unambiguous SVO and OVS sentences and the second with temporarily ambiguous SVO and OVS sentences. Below we present the research questions of the two experiments, where (a) indicates a connection with experiment 4.1 and (b) a connection with experiment 4.2.

(1a) How do L1 and L2 children interpret unambiguous SVO and OVS sentences off-line?

(1b) How do L1 and L2 children interpret temporarily ambiguous SVO and OVS sentences off-line?

2a/b) i) Unambiguous sentences/temporarily ambiguous sentences: do L1 and L2 children differ in the on-line weight they assign to the "agent-first strategy" and to case-marking during real-time comprehension when they are in coalition and competition with each other?
ii) Do L1 and L2 children integrate the "agent-first strategy" and case-marking at different time points in the sentence?

(3a/b) Are there differences between children's off-line and on-line performances? Specifically, do participants react to the cues on-line to a different degree than the one shown in the off-line task?

5.5.2 Experiment 4.1: study with unambiguous SVO and OVS sentences

5.5.2.1 Participants

Participants were ten 7-year-old German children (5 female and 5 male; age range = 7,1-7,8; mean age 7,5 years; SD = .2449) and eleven 7-year-old Turkish-German children (5 female and 6 male; age range = 6,6-7,6; mean age: 6.9; SD = .4763). At the time of the data collection, they were attending the end of the first year of primary school in Germany. The 7-year-olds involved in this study were similar to the 7-year-olds in the study described in chapter 3 (passive study) as regards the onset of the L2, which occurred around the ages of 3 and 4, and the language habits they were exposed to at home. Detailed biographical information is provided in Appendix A.4. Participants were recruited and tested in schools in Osnabrück and Berlin. All children had normal or corrected-to-normal vision and were naïve as regards the purpose of the experiment. In compensation for their participation in the study, they received a child-friendly certificate.

5.5.2.2 Language proficiency of the 7-year-olds

The same *Elicited Imitation Test* as described in chapter 3 was adopted to assess the children's language proficiency (section 3.3.3.2 provides a description of the task and the materials employed). For each group, we converted the absolute average value into percentages. The L1 children achieved scores of 98% and 67% respectively for accurately repeating correct items and correcting incorrect items, while the L2 children achieved average values of 90% and 31%. When these proficiency results are broken down by linguistic phenomenon, it becomes clear that the weaker performance by L2 children in both tasks was not concentrated in any one of the four structures investigated but rather evenly distributed among them.[39] Two independent sample t-tests were executed, one for the condition in which participants were given grammatically correct items and one for the condition in which participants were

[39] The four linguistic phenomena under study were nominal case-marking, subject-verb agreement, adjective inflection and inversion. Percentages for each of these phenomena were as follows. Corrected repetitions of correct items: L1 children, 100%, 100%, 97% and 97%; L2 children, 88%, 85%, 88% and 100%. Corrected repetitions of incorrect items: L1 children, 77%, 63%, 67% and 70%; L2 children, 36%, 30%, 27% and 27%.

given grammatically incorrect items. In the first test, the differences between the L1 and L2 children in repeating the items correctly were significant in the participant analysis only ($t1(19) = -2.359$, $p = .029$; $t2(22) = .222$, $p = .826$). In the second test, the differences in normalizing incorrect items were significant in both analyses ($t1(19) = -2.986$, $p = .008$; $t2(22) = -4.534$, $p < .05$). These scores indicate that the overall grammatical knowledge of the L2 children was lower than that of the L1 children.

5.5.2.3 Materials

The materials used were the same as those employed in the previous study (experiment 3.1 with L1 children and adults) as thoroughly described in chapter 4.6.2.2. Participants were thus presented with sixteen experimental sentences, eight unambiguous SVO and eight OVS sentences, twelve warm-up items and sixteen filler-items.

5.5.2.4 Procedure

The same procedure as that described in chapter 4.6.2.3 was used.

5.5.2.5 Coding

For the analysis of the eye gaze movements we measured the same time segments as in the previous study involving OVS sentences as described in chapter 4. However, to facilitate comprehension of the present study, we detail below in table 7 the segments under investigation.

	Time Segment 1	**Time Segment 2**	**Time Segment 3**		
	Sentence Onset 200+500ms (1stNP)	**Onset AUX 200-900ms**	**Onset 2nd NP + PPART 200-700ms**	**700-1400ms**	**1400-2100ms**
SVO	Der Vater	hat am Abend	die Mutter sehr lange geküsst		
OVS	Den Vater	hat am Abend	die Mutter sehr lange geküsst		

Table 7: Time segments (Experiment 4.1 of study 4), selected on the basis of cue onset

In the same vein as in the previous study, the dependent variable was the sum of gaze fixations on the target and competitor pictures calculated in 20 ms intervals. Trials without an answer were excluded from the analysis. Unlike in the previous study comparing L1 adults with L1 children, we conducted separate analyses for the two groups of subjects. We opted for this approach because the full model including a three-way interaction between Language Group (German as L1, German as L2), Image (congruent, incongruent) and Sentence Type (SVO, OVS), as well as participants and items as random effects including random slopes by participants and items for all fixed factors and their interactions mostly did not converge until the fixed factors were removed from the random slopes. As we were interested in computing a model which also took into consideration the effects of participants and items, our model included a two-way interaction of the fixed factors Image and Sentence Type with the corresponding random slopes. Each converging model was compared by means of a log-likelihood ratio test with the anova function in R with a simpler model with just the two fixed factors as main effects and the same random slopes as the first model with the fixed effects in interaction.

Both accuracy and eye movement data were analysed with logistic mixed effect models using R (R Development Core Team, 2012) and the R packages *lme4* and *languageR*. Effects of interest for our research questions are main effects of Image, indicating a significantly different preference for the congruent or incongruent picture during SVO or OVS sentences, and interactions between Sentence Type and Image, reflecting the preference for the congruent or incongruent picture in one Sentence Type condition and the opposite in the other Sentence Type condition as well as a potential difference in the robustness of the interaction between the groups.[40]

5.5.2.6 Results

5.5.2.6.1 Accuracy

The L1 German 7-year-olds were highly accurate in the SVO condition, producing a 92.5% score, whereas in the OVS condition, their performance was only slightly

[40] We will not discuss main effects of Sentence Type as we have no hypothesis to explain this factor.

above chance at 56%.[41] The L2 children scored 87% and 31% respectively for SVO and OVS sentences.[42] For the accuracy data, the dependent variable was whether participants chose the target or competitor picture. The analysis was conducted separately for the two groups like in the analysis of the eye movements described below, so the model included only the factor Sentence Type (active, passive) as well as participants and items as random factors, with individual slopes for Sentence Type (lmer and binomial family in R) (Baayen, 2008; Barr et al., 2013; Jaeger, 2008). In both child groups, we found a main effect of Sentence Type (L1 children: estimate = 2.6832, std = 0.5592, z = -4.799, p = 0; L2 children: estimate = 3.0754, std = 0.5180, z = 5.937, p = 0). The main effect of Sentence Type in both child groups indicates that there was a significant difference between the processing of the SVO and OVS sentences. Percentages show that in both groups performance was indeed higher during SVO than OVS sentences.

[41] One trial (1.25%) involving an OVS sentence was excluded from the analysis because no answer was detected.

[42] Ten trials (11.3%) in total were excluded from the analysis of the L2 children (two trials in the SVO condition because participants provided no answer and four trials because no answer was detected, probably because participants pressed the button too long and the trial was skipped; another four trials in the OVS condition were excluded for the same reason).

5.5.2.6.2 Eye movement data

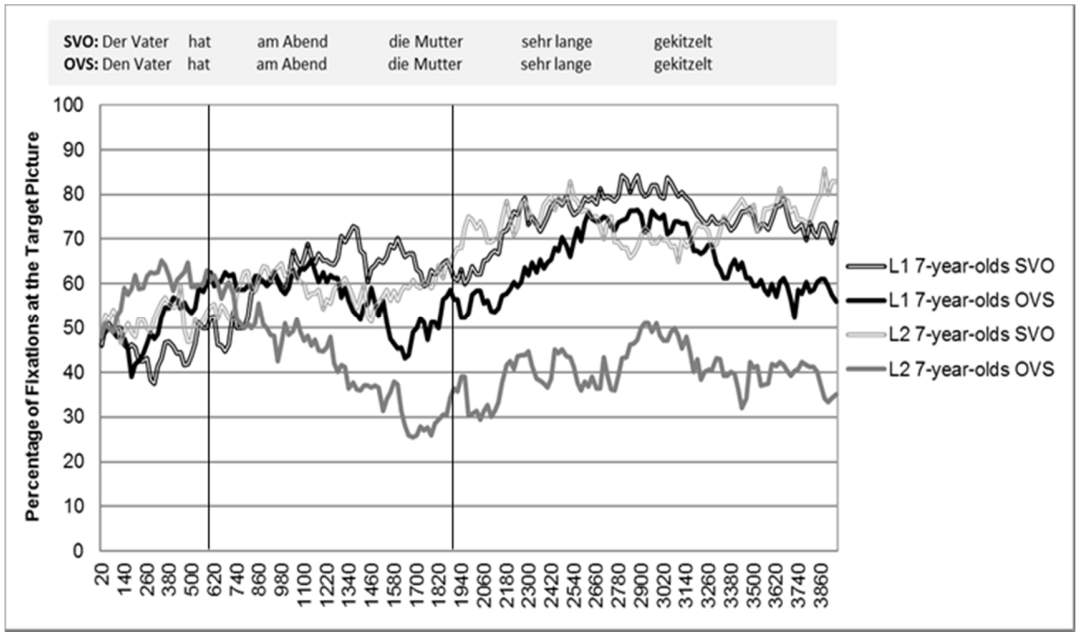


Figure 26: Plot of language-group averages for gaze fixations from start to finish of trial (unambiguous SVO and OVS sentences with masculine first NP, including correct and incorrect trials), showing percentages of fixations directed at the target picture

Figure 26 shows plots of the percentage of fixations on the target picture out of all fixations in the SVO and OVS condition for the full time-course of the experimental sentences, broken down by Language Group. Inspections of Figure 26 indicate that in the SVO condition, both groups were at ceiling, showing no great differences in processing. During OVS sentences, however, a clear-cut difference between the two groups can be observed, with the L1 children directing around 20% more fixations at the target picture than the L2 children. Nevertheless, it is interesting to note that the course of the OVS plot is not very different between the groups as the lines, albeit at different levels, increase and decrease at the same time points in the sentence. This suggests that although the two groups react to the "agent-first strategy" and case-marking similarly, the intensity with which they rely on them is different. In other words, they seem to assign a different weight to the cues.

Time Segment 1: unambiguous masculine first NP (SVO, der Vater; OVS, den Vater)

Figure 27: Gaze fixation during the unambiguous masculine nominative or accusative first NP: plot of language-group averages for gaze fixations from start of trial (unambiguous SVO and OVS sentences with masculine first NP, including correct and incorrect trials) until 500 ms, showing percentages of fixations at the target picture

The first time segment includes the time when participants heard the first NP, the masculine nominative- or accusative-marked first NP. In analyses of both the L1 and the L2 children, we found no effects of Image or interaction of Image with Sentence Type.

Discussion: Time Segment 1

This absence of effects suggests that hearing the first NP which already disambiguates the sentence as a SVO and OVS does not trigger any particular strategy. Both groups seem to inspect both pictures to the same degree, as shown by the fact that target fixations remain around the 50% area.

Time Segment 2: auxiliary (SVO/OVS, hat)

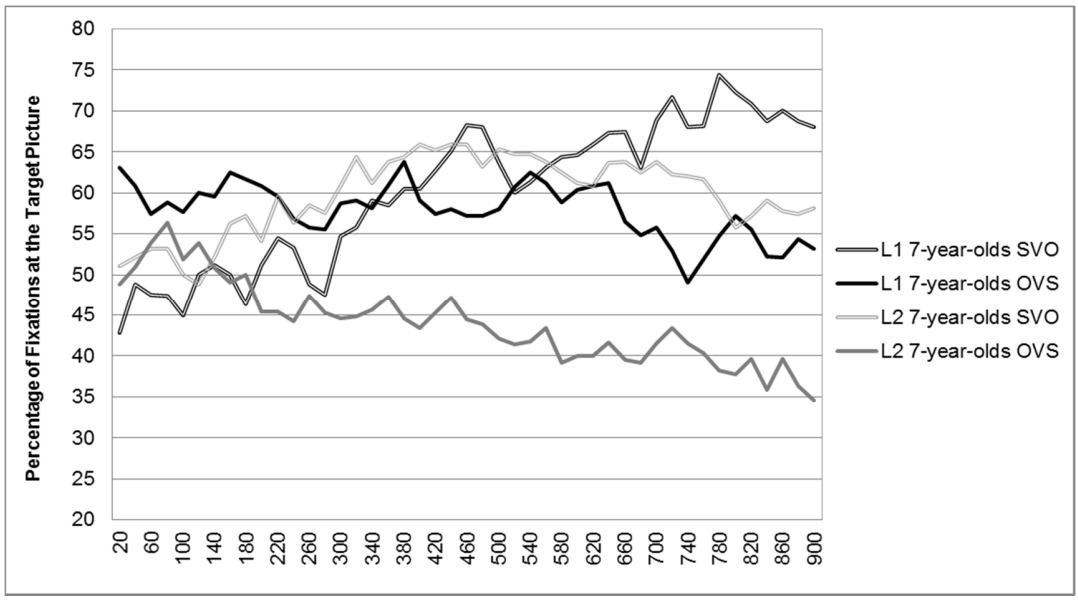


Figure 28: Gaze fixation during the auxiliary and the adverb: plot of language-group averages for gaze fixations from the onset of auxiliaries until 900 ms (unambiguous SVO and OVS sentences with masculine first NP, including correct and incorrect trials), showing percentages of fixations at the target picture

For the L1 children, we found a main effect of Image with no additional effects. The main effect of Image reflects the higher number of fixations directed at the target than the competitor picture in both conditions. For the L2 children, we found a two-way interaction between Image and Sentence Type. Separate analyses by Sentence Type revealed a significant effect of Image in the SVO condition only. The interaction is due to the higher number of target fixations in the SVO than in the OVS condition. The fact that in the separate analysis the main effect of Image reached significance in the SVO condition only suggests that L2 children's tendency to prefer the target picture while listening to canonical sentences was more robust than their tendency to fixate on the competitor picture when they listened to non-canonical sentences.

Discussion: Time Segment 2

For the L1 children, it seems that they recognized the accusative cues in initial position and understood that, unlike in the other condition, the first NP is not the agent of the sentence. On the other hand, the interaction seen in the L2 children's analysis suggests that they interpreted both sentences according to an "agent-first strategy", putting them on the right track in the SVO but not in the OVS condition.

The significant effect of Image in the SVO condition only indicates that this strategy was more robust in this condition. This might indicate that L2 children did not completely ignore the accusative marker in the first NP and for this reason their "agent-first strategy" was less pronounced.

Time Segment 3: 2nd NP (SVO/OVS, die Mutter) + past participle

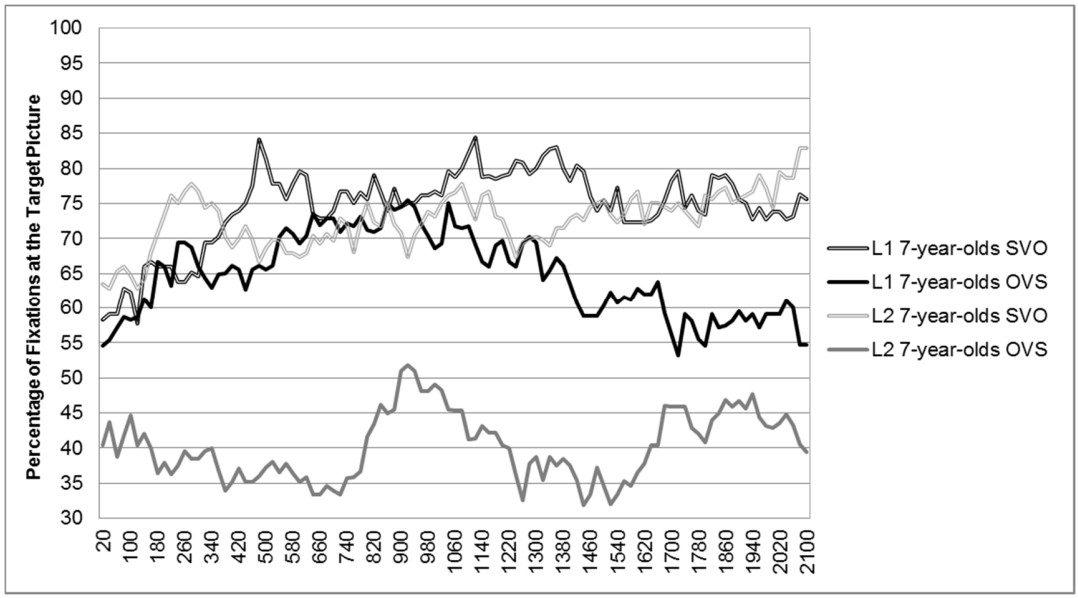


Figure 29: Gaze fixation during the 2nd NP, adverb and past participle: plot of age-group averages for gaze fixations from the onset of the 2nd NP until 2100 ms (unambiguous SVO and OVS sentences with masculine first NP, including correct and incorrect trials), showing percentages of fixations directed at the target picture

200-700

In the analysis of the L1 children, we found only a main effect of Image without additional effects. Descriptively, the main effect only for the L1 children reflects the high number of target fixations in both conditions. For the L2 children, the two-way interaction between Sentence Type and Image achieved significance. Further analyses of this interaction by Sentence Type showed a significant main effect of Image in both conditions. The interaction is due to the higher number of fixations directed at the target picture for SVO sentences and at the competitor picture during OVS sentences.

700-1400

The same effects as in the first segment of the time window (200-700) were significant.

1400-2100

For the L1 children, in this time segment of the sentence the two-way interaction between Image and Sentence Type reached significance. Separate analyses of the interaction by Sentence Type revealed an effect of Image in the SVO condition only. This pattern reflects the decrease in target fixation in the OVS condition, such that target fixations were higher in the SVO than in the OVS condition. The main effect of Image during SVO sentences indicates that during SVO the preference for the correct picture was significantly different than the preference for the competitor, whereas in the OVS condition there was no clear preference for either of the two pictures, as shown by target fixations close to the 50% line. For the L2 children, the effects were the same as those found in the previous two parts of the time window, namely a significant interaction between Image and Sentence Type and main effects of Image in the separate analyses by Sentence Type.

Discussion: Time Segment 3

The eye movement behaviour of the L1 children suggests that they were interpreting SVO sentences correctly. During OVS sentences they were on the right track until the second part, whereas during the last part of the time segment target fixations started to decrease, reaching chance level by the end of the time window. Regarding the L2 children, despite the permanent interaction in all three parts of the segment, indicating more target fixations during SVO than OVS sentences and therefore the use of an "agent-first strategy", these subjects also reveal a slight increase in the OVS condition, which decreases shortly afterwards. In other words, although this increase and consequent decrease does not emerge from the statistical analysis, inspections of the graph indicate that the L2 children also seemed to exploit case-marking, even if to a much lower degree than the L1 children.

Summary

The on-line data show that the L1 children looked more at the correct picture than at the incorrect picture while listening to both SVO and OVS sentences. At the end of the OVS sentences, however, before the children selected a picture (i.e., before they performed the off-line task), the number of target fixations decreased sharply in this condition while it remained high during SVO sentences. This pattern indicates that ultimately the correct analysis could often not be maintained. On the other hand, the L2 children started and ended their interpretation of both sentence types with an "agent-first strategy". Importantly, target fixations in the SVO and OVS conditions did not result in a completely symmetrical mirror image since we found fewer gazes directed at the incongruent picture during OVS sentences than gazes directed at the congruent one during SVO sentences. This suggests that L2 children were not completely insensitive to the accusative case-marking.

5.5.3 Experiment 4.2: study with temporarily ambiguous SVO and OVS sentences

5.5.3.1 Participants

Ten monolingual German children (8 female and 2 male; age range = 6,7-7,8; mean age 7,4 years; SD = .3804) and nine German-Turkish children (3 female and 6 male; age range = 6,6-7,4; mean age 6,9 years; SD = .4926) participated in the experiment. Both child groups were attending the first year of the German primary school system. The children had the same characteristics as those who participated in experiment 4.1. Detailed biographical information is provided in Appendix A.4.

5.5.3.2 Proficiency of the 7-year-olds

For each group, we converted the absolute average value into percentages. The L1 children achieved scores of 99% and 89% respectively for accurately repeating correct items and correcting incorrect items, while the L2 children achieved average values of 77% and 43%. Two independent sample t-tests were executed, one for the condition in which participants were given grammatically correct items and one for the condition in which participants were given grammatically incorrect items. In the first test, the differences between the L1 and L2 children in repeating the items correctly were significant in both participant and item analyses ($t1(17) = 2.313$, $p = .034$; $t2(22) = 4.005$, $p = 0.34$). In the second test, the differences in normalizing incorrect items were significant as well in both analyses ($t1(17) = -2.810$, $p = .012$; $t2(24) = -4.461$, $p < .05$). These scores together indicate that the overall grammatical knowledge of the L2 children was both descriptively and statistically lower than that of the L1 children. Analysis broken down by linguistic phenomenon indicated that the changes produced by the L2 children in both conditions were not concentrated on any one of the four structures being investigated but rather were distributed among them.[43]

[43] The four linguistic phenomena under study were nominal case-marking, subject-verb agreement, adjective inflection and inversion. Percentages for each of these phenomena were as follows. Corrected repetitions of correct items: L1 children, 100%, 100%, 97% and 100%; L2 children, 81%, 93%, 85% and 96%. Corrected repetitions of incorrect items: L1 children, 83%, 73%, 80% and 70%; L2 children, 37%, 41%, 52% and 41%.

5.5.3.3 Materials

The same materials were used as in the previous study in chapter 4.6.3.2 (experiment 3.2 with L1 children and adults). Participants were presented with sixteen experimental sentences, twelve warm-up items and sixteen filler-items. Each experimental item was presented in either the SVO or OVS condition. This experiment included only temporarily ambiguous sentences.

5.5.3.4 Procedure

The same procedure as that followed in chapter 4.6.3.3 was executed.

5.5.3.5 Coding

Coding was carried out as in experiment 3.2 in chapter 4. Likewise, for the analysis of the eye-tracking data, the experimental sentences were again divided into three main time segments.

	Time Segment 1	**Time Segment 2**	**Time Segment 3**		
	Sentence Onset 200+500ms (1stNP)	**Onset AUX 200-900ms**	**Onset 2nd NP + PPART 200-700ms**	**700-1400ms**	**1400-2100ms**
SVO	Die Mutter	hat am Abend	den Vater sehr lange geküsst		
OVS	Die Mutter	hat am Abend	der Vater sehr lange geküsst		

Table 8: Time segments (Experiment 4.2 of study 4), selected on the basis of cue onset

5.5.3.6 Results

5.5.3.6.1 Accuracy

The L1 7-year-olds were accurate in the SVO condition, with a 90% accuracy rate, but misinterpreted almost all OVS sentences, with a 9% accuracy rate.[44] The L2 children were also at ceiling in the SVO condition, yielding an 89% accuracy rate, but produced a similarly low accuracy rate (13%) in the OVS condition.[45] Separate statistical analyses for the two groups revealed a main effect of Sentence Type in both (estimate = -4.4125 std = 1.0476, z = -4.212, p = 0; estimate = -2.87047, std = 0.58079, z = -4.942, p = 0). The main effect of Sentence Type in both child groups indicates that there was a significant difference between the processing of the SVO and OVS sentences. Percentages show that indeed performance was higher during SVO than OVS sentences in both groups.

[44] Nine trials in total were excluded from the analysis. One trial in the SVO (1.3%) condition and three trials in the OVS (3.8%) condition elicited no answer, whereas two trials in the SVO condition (2.5%) and three trials (3.8%) in the OVS condition were classified as "skipped trials" because no eye-gaze was detected, probably because participants pressed the key too long and the program moved on to the next trial).

[45] Five trials in total in the OVS condition were excluded from the analysis. Three of them (4.2 %) elicited no answer while the other two (2.8%) were labelled as "unclassified".

5.5.3.6.2 Eye movement data

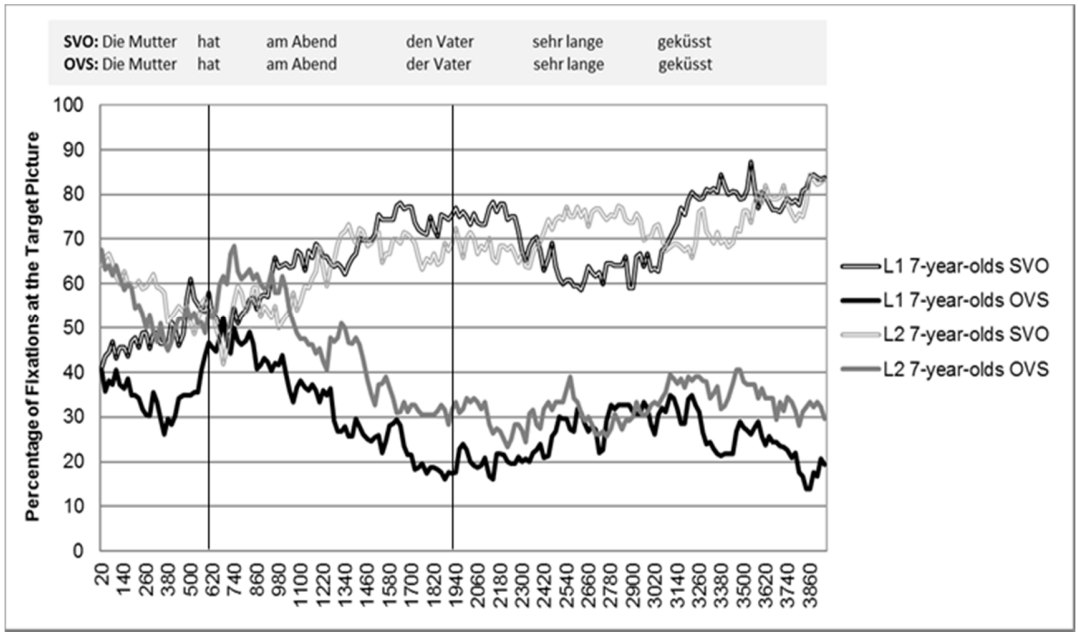


Figure 30: Plot of language-group averages for gaze fixations from start to finish of trial (temporarily ambiguous SVO and OVS sentences with feminine first NP, including correct and incorrect trials) showing percentages of fixations directed at the target picture

Figure 30 shows plots of the percentage of fixations directed at the target picture out of all fixations in the SVO and OVS conditions for the full time-course of the experimental sentences and separated by language group. Inspections of Figure 30 reveal a fairly symmetrical mirror image in the results for both L1 and L2 children. Target fixations were very high during SVO sentences whereas during OVS sentences the number of target fixations remained low in both groups until the end of the sentence.

Time Segment 1: ambiguous feminine first NP (SVO/OVS, die Mutter)

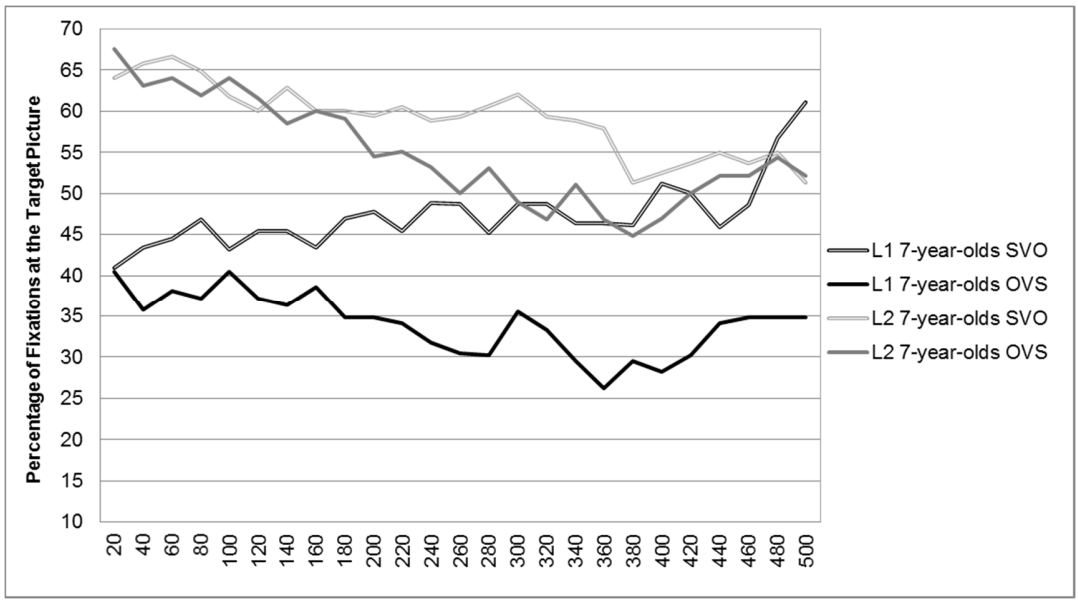


Figure 31: Gaze fixation during the unambiguous masculine nominative or accusative first NP: plot of language-group averages for gaze fixations from start of trial (temporarily ambiguous SVO and OVS sentences with feminine first NP, including correct and incorrect trials) until 500 ms, showing percentages of fixations at the target picture

The first time segment includes the time when participants heard the first NP, which, being feminine is ambiguous between the nominative and accusative cases. In analyses of both the L1 and the L2 children, we found no effects of Image or interaction of Image with Sentence Type.

Discussion: Time Segment 1

The absence of effects suggests that during the first ambiguous NP both child groups did not inspect one picture more than any other, indicating the absence of any particular strategy favouring one interpretation over the other.

Time Segment 2: auxiliary (SVO/OVS, hat)

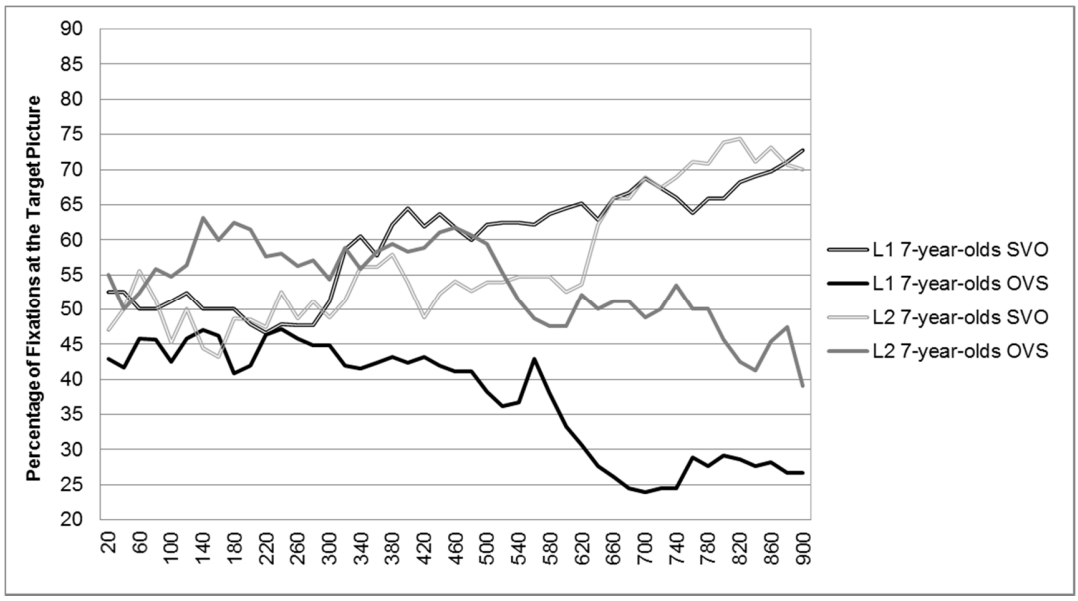


Figure 32: Gaze fixation during the auxiliary and the adverb: plot of language-group averages for gaze fixations from the onset of auxiliaries until 900 ms (temporarily ambiguous SVO and OVS sentences with feminine first NP, including correct and incorrect trials), showing percentages of fixations at the target picture

For the L1 children, we found a significant two-way interaction between Image and Sentence Type but no additional effects. Separate analysis of the interaction revealed a significant main effect of Image during OVS sentences only. The interaction reflects the higher fixations during SVO than OVS sentences and the main effect of Image during OVS sentences reflects the higher number of fixations directed at the competitor picture than at the target. The absence of an effect of Image during SVO sentences indicates that the difference between fixations at the target and competitor picture was not significantly different in this condition. Analysis of the L2 children showed no significant effects.

Discussion: Time Segment 2

The interaction detected in the results for the L1 children suggests that after the first NP they started to adopt an "agent-first strategy" to interpret ambiguous sentences. It is more difficult to explain, however, why Image has an effect during the OVS condition only given that in this time segment no disambiguation cue is yet available to disambiguate the sentences as SVO or OVS. The absence of effect for the L2

children shows their lack of a proper strategy for processing the sentences. However, descriptively, target fixations at the end of the time segment start to diverge, showing a mirror image similar to what we see for the L1 children.

Time Segment 3: 2nd NP (SVO, den Vater; OVS, der Vater) + past participle

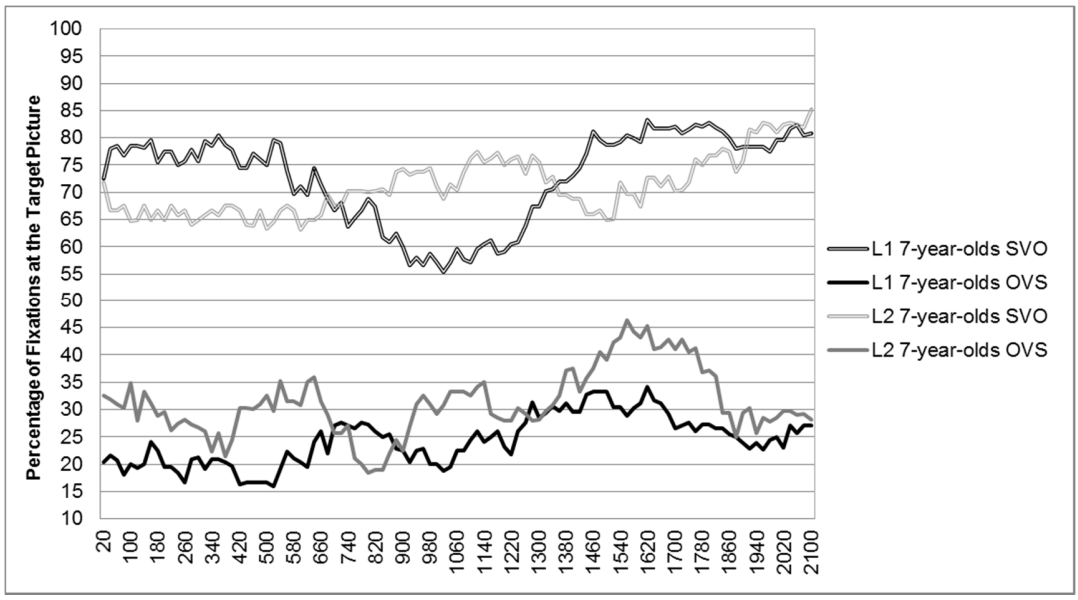


Figure 33: Gaze fixation during the 2nd NP, adverb and past participle: plot of age-group averages for gaze fixations from the onset of the 2nd NP until 2100 ms (temporarily ambiguous SVO and OVS sentences with feminine first NP, including correct and incorrect trials), showing percentages of fixations directed at the target picture

200-700

For this time segment, the same effects were found in both groups. The interaction between Image and Sentence Type reached significance as shown by the higher number of fixations on the target picture in the SVO and on the competitor image in the OVS condition. Separate analysis of the interaction revealed a main effect of Image in both conditions, indicating a preference for the target picture in the SVO condition and for the competitor picture in the OVS condition.

700-1400

The same effects as in the previous time segment (200-700) were found.

1400-2100

Again, the same effects as in the previous time segment (700-1400) were found.

Discussion: Time Segment 3

This time segment includes the onset of the disambiguating accusative-marked NP for SVO and nominative-marked NP for OVS sentences. However, the onset of these cues seems to have no influence on their processing as both child groups continue with their "agent-first strategy", thus proceeding to correctly interpret SVO sentences but not showing any attempt to revise their initial incorrect interpretation of OVS sentences.

Summary

During the first NP neither child group seemed to adopt any particular strategy. Shortly afterwards, with the onset of the auxiliary, L1 children started to process the temporarily ambiguous sentences according to an "agent-first strategy", which put them on the right track for SVO but not OVS sentences. The L2 children also made use of this strategy, though later than the L1 children, almost at the end of time segment 2. With the onset of the disambiguating cue, both groups were exploiting the "agent-first strategy" to the same degree and neither proved able to revise this strategy during OVS sentences. A very small attempt can be seen at the end of the plots, but it is not statistically significant.

5.6 General Discussion

In the present study we tested 7-year-old L1 and L2 German-learning children with SVO and OVS sentences presenting two points of disambiguation by case-marking. In experiment 4.1, children were tested with unambiguous SVO and OVS sentences and in experiment 4.2 with temporarily ambiguous SVO and OVS sentences. For the discussion of the results we follow our three research questions:

1a) How do L1 and L2 children interpret unambiguous SVO and OVS sentences off-line?

When, after listening to a sentence, L1 children were instructed to select the picture corresponding to the sentence they had heard, they performed at around chance level. When compared to the results obtained in previous studies, the present off-line scores are in line with those found by Schipke et al. (2012), but diverge from those obtained by Dittmar et al. (2008) and Schaner-Wolles (1989).

Dittmar et al.'s (2008) L1 subjects achieved a score of 63% correct picture selection, so our results differ from theirs by about 13% points. One reason for the better performance in the Dittmar et al. study might be the fact that children were presented with nine different film scenes and were asked to point to the correct one. In the present study actions were represented by still pictures, so it may be that in the Dittmar et al. study the animation itself facilitated the children's recognition of the correct distribution of the thematic roles, since the action was explicitly acted out. Moreover, in the Dittmar et al. study the children were instructed to point to the correct picture and not to press a button on the keyboard (as in our study), which may also have facilitated their choice, since the act of pointing might be considered a more natural response than the pressing of a button. Finally, since the Dittmar et al. study was conceptualized for younger groups, it included fewer trials than the present one (9 vs. 16).

Very different indeed from the off-line score obtained in our study is the result obtained by Schaner-Wolles (1989), with L1 5-year-olds showing much higher accuracy scores already at age 5 (89% of correct responses). In the study, nine 5-year-olds were tested exclusively on non-canonical sentences, twelve of them passive

sentences and the other eight OVS sentences. Four of the OVS sentences were similar to those used in this study except for the fact that in two of them the second NP was neuter (*Den Vater*-ACCMASCUNAMB *frisiert das Mädchen*-NOMFEMAMB, 'the fatherACC combs the girl-NOM') whereas we used only feminine nouns, and in the other two the second NP was masculine, including thus a second unambiguous marker (*Den Vater*-ACCMASCUNAMB *fotografiert der Bub*-NOMMASCUNAMB, 'the father-ACC photographs the boy-NOM'). However, the fact that the experiment had fewer items relative to ours (2 vs. 8 in the current study) makes the results not directly comparable. Furthermore, the Schaner-Wolles study did not include any canonical agent-first NP sentences, so it might also be that participants were biased against processing the first NP as the agent. As for our L2 children, they performed much lower than the L1 answering only 31% of the items correctly.

The only study to our knowledge testing the "agent-first strategy" in competition with case-marking is the study by Roesch and Chondrogianni (2014) involving wh-object-questions. At age 5 French-German children were shown to rely more on the "agent-first strategy" than on case-marking and to perform lower than the age-matched L1 children (L2 children were lower than 40%) so the present low off-line scores of the L2 7-year-olds seem to be in line with it.

1b) How do L1 and L2 children understand temporarily ambiguous SVO and OVS sentences off-line?

Both child groups performed very low, very often misunderstanding OVS sentences that are temporarily ambiguous and interpreting them as if they were canonical SVO sentences. The very low off-line scores in both groups come as no surprise since previous studies already reported strong garden-path effects with these sentences in both L1 and L2 children (Biran & Ruigendijk, 2015; Gamper, 2016; Mills, 1977). Moreover, it is important to recall that these sentences are highly challenging even for more experienced learners, as shown by the low scores of German adults in chapter 4. As we will further discuss in the following section, the present findings confirm the hypothesis that the longer the ambiguous region, the more difficult it is for the parser to reanalyse the sentence, thereby blocking the analysis based on the "agent-first

strategy" that he or she has pursued since the beginning of the sentence (Bader & Meng, 2000; Ferreira & Henderson, 1991).

2a) i) Unambiguous sentences: do L1 and L2 children differ in the on-line weight they assign to the "agent-first strategy" and to case-marking during real-time comprehension when they are in coalition and competition with each other?
ii) Do L1 and L2 children integrate the "agent-first strategy" and case-marking at different time points in the sentence?

During canonical SVO sentences, L1 and L2 children were shown to react very similarly to the active morphosyntactic cues which are in coalition with the "agent-first strategy", thus increasingly assigning the thematic role of agent to the first NP as the active cues intervened (coalitions-as-prototypes model; Bates & MacWhinney, 1987). In the OVS condition, the L1 children revealed sensitivity to the accusative case-marking on the first NP. More precisely, our analysis of the L1 children's behaviour shows that during OVS sentences they had a preference for the target picture which started after the accusative-marked NP, with the onset of the second NP, and continued to increase almost until the end of the sentence, reaching at its peak a target fixations rate of 75%. However, in the final part of the sentence, slightly before the children performed the off-line task, target fixations started to decrease, ultimately falling back to chance level. A proper "agent-first strategy" is not observable, since there is no point in the sentence at which L1 children reveal target fixations below chance level. However, the fact that target fixations were at first slightly above chance and then slowly rose to reach 75% almost at the end of the sentence, after the onset of the second NP, might indicate that the L1 subjects were relying on case-marking but preferred to wait until the second NP, in order to have a double confirming cue that the first NP is truly not the subject but the object. This finding is compatible with what was observed in the study by Schipke et al. (2012) who used EEGs to measure the brain potentials of 6-year-olds. The study provided evidence that L1 children were sensitive to the accusative case-marking in initial position, as also revealed by the adult control group, but by the end of the sentence their performance was merely at chance level because of a failure to integrate the

second NP (see discussion (3a) below regarding off-line vs. on-line results for a more detailed comparison of the two).

By contrast, our analysis of the L2 children's results reveals a very weak reaction to the accusative case-marking in the OVS condition. Recall that target fixations in the SVO and OVS conditions resulted in a mirror image, with higher target fixations in the SVO than in the OVS condition. However, the mirror image was not entirely symmetrical, meaning that fewer fixations were directed at the target picture in the SVO condition than fixations directed at the incorrect picture in the OVS condition. This suggests that L2 children were making use of an "agent-first strategy" to interpret both sentences, but since it was weaker in the OVS condition than in the SVO condition, this implies that they did react to some extent to the accusative case-marking on the first NP.

One plausible explanation for this finding might be that L2 children have overall less experience with OVS sentences than L1 children, that is, with situations in which the "agent-first strategy" is in competition with case-marking. Although production studies demonstrate that L2 children learn to produce the accusative case after a brief time from L2 acquisition onset (see, among others, Clahsen, 1984; Kaltenbacher & Klages, 2006), meaning that they know that *den* is an accusative marker, they have difficulty relying on this cue when it competes with the "agent-first strategy". Their reliance on this processing interpretation is so pronounced in the initial stages of acquisition that, in line with the previous explanation, it is also plausible that the L2 children misheard the article *den* in the first NP, simply ruling out the possibility that an accusative marked NP can precede the verb. Moreover, the article *den* is not phonetically salient, which may have added to their difficulty in recognizing it.

2b) i) Temporarily ambiguous sentences: do L1 and L2 children differ in the on-line weight they assign to the "agent-first strategy" and to case-marking during real-time comprehension when they are in coalition and competition with each other?
ii) Do L1 and L2 children integrate the "agent-first strategy" and case-marking at different time points in the sentence?

The eye movement plots for the two groups in this condition are almost identical. Both child groups started interpreting the sentences with an "agent-first strategy" and thus assigned to the ambiguous feminine NP the role of agent. This strategy was adopted earlier by the L1 than the L2 children, but by the end of the sentence it had achieved the same level descriptively as well as the same results statistically. During the second NP, with the onset of the disambiguating cue, both groups were unable to revise their initial erroneous analysis based on the "agent-first strategy". This pattern confirms previous studies with children which show that, due to their less developed inhibitory capacities, they have difficulty abandoning cues when they have already committed themselves to one interpretation (Choi & Trueswell, 2010; Trueswell et al., 1999). Furthermore, as also shown by studies with older participants, the position of the disambiguating cue in a sentence affects the successful interpretation of that sentence. In other words, the longer the ambiguous region or the later in the sentence the disambiguating cues arise, the more difficult it is for the parser to inhibit initial commitments in favour of new cues (Bader & Meng, 2000; Ferreira & Henderson, 1991).

Alongside the factors of lower executive functions in children and cue position in the sentence, it also seems that the type of cue that children initially commit themselves to might play a role. More precisely, the "agent-first strategy" is for both groups a highly valid expectation at that age which they weight more than case-marking, as also shown by previous off-line studies (e.g., Chan et al., 2009; Dittmar et al., 2008). Confirmation of the high value of this expectation is also provided by Marinis's (2007) study involving passive sentences in German. He shows that although L2 children made use of the passive morphosyntax, they were less accurate than L1 children in the off-line comprehension task, largely resorting to the "agent-first strategy". He explains this by arguing that L2 children rely more on simple heuristics and the "agent-first strategy" is in general a much easier and less expensive strategy for comprehenders. Against this background, the lack of reaction to the accusative case-marking during the second NP seen in our own study might also indicate that as L2 children listen to the sentence, it is difficult for them to stop relying on the "agent-first strategy", which is a valid and less expensive expectation,

and start relying instead on a cue with which they have less experience in that position in the sentence.

3a) Unambiguous sentences: are there differences between children's off-line and on-line performances?

A comparison of L1 children's off-line and on-line comprehension in the OVS condition reveals that while their off-line performance is at chance, indicating no clear preference for either the "agent-first strategy" or case-marking, their on-line behaviour provides us with a different insight into how they exploit the cues. Crucially, L1 children reacted to case-marking on-line to a much stronger degree than during the off-line task. The fact that by the end of the sentence their target fixations – which peaked around 75% – had decreased and off-line performance was at chance is consistent with previous studies comparing children's off-line and on-line comprehension which concluded that analysing children's on-line behaviour can help to build a more complete picture of their knowledge of cues (Adani & Fritzsche, 2015; Schipke et al., 2012). Specifically, it seems that even if children have linguistic knowledge of the cues and are on the right track in interpreting the non-canonical sentences, they are not able to hold in memory the correct OVS interpretation until the end of the sentence and then use it to override a subsequent interpretation based on the "agent-first strategy". For this reason, at the end of the sentence and in the off-line task they go back to the less costly "agent-first strategy". Moreover, it is noteworthy the fact that L1 children, before starting to correctly interpreting OVS sentences, adopted a strategy of waiting and cheking the second NP in order to see whether it suits with a potential interpretation of the first NP as object or not. These tasks, namely "waiting and checking" the second NP and then keeping the correct interpretation until the end while continuing inhibiting the parallel "agent-first strategy" suggests the difficulty of OVS sentences more from an executive function perspective than a linguistic one.

As regards the L2 children, a similar conclusion can also be drawn, as the on-line data also revealed that participants were not completely indifferent to the accusative case-marking, as shown by the low off-line scores, but did make less use

of it during as they listened to the sentences. This finding is in line with the results of the study by Marinis (2007) showing that Turkish-English children were sensitive to the passive morphosyntax but in the end interpreted the sentences relying strongly on the "agent-first strategy". However, it is important to mention that, unlike in the Marinis study, the present L2 children exploited case-marking to a much lesser degree than the L1 children. Recall that Marinis found that L2 children were only slower in reacting to the passive morphosyntax during the self-paced listening task and argued that processing between L1 and L2 children was qualitatively similar (see also Chondrogianni & Marinis, 2012; Marinis, 2008 for similar results). Although direct comparison between an eye-tracking study and a self-paced listening task is of arguable validity, since the former measures participants' interpretation preferences while the latter measures difficulties during processing, the difference we found in target fixations between the two groups in the OVS condition was much more pronounced than the difference in the reaction times between the L1 and L2 children in the Marinis study. This indicates that the processing of OVS sentences between L1 and L2 children is not as similar as what is suggested in previous research and raises the question as to why performance between the groups is different. No argumentation related to the children's executive functions would seem apt to explain the pattern we found here. We would rather have expected the L2 children to have more developed inhibitory abilities than L1 children and thus be better in inhibiting irrelevant cues, such as the "agent-first strategy".

What it seems more plausible to explain the L2 child data is the children´s linguistic knowledge. As already suggested above, despite the fact that L2 children are assumed to have mastered case-marking by age 7, it seems that they find it difficult to rely on it in isolation, that is, when it conflicts with the "agent-first strategy", as the result of their having had overall less experience with the "agent-first strategy" and case-marking in competition. Moreover, the heavy weight they assign to the the "agent-first strategy" might also be responsible for their difficulty in reacting to the conflicting case-marking.

3b) Temporarily ambiguous sentences: are there differences between children's off-line and on-line performances?

Experiment 4.2 with temporarily ambiguous OVS sentences reveals that both child groups performed very poorly in both off-line and on-line tasks. First of all, it is important to point out that it is unnatural to encounter either temporarily ambiguous or unambiguous OVS sentences in isolation, that is, not embedded in a discourse context and shorn of pragmatic marking. Secondly, the fact that, in experiment 4.1 with unambiguous OVS sentences, both groups of children reacted to the accusative marking (albeit the L2 children to a lesser degree) whereas in experiment 4.2 neither group showed any particular sensitivity to case-marking indicates that, independent of participants' linguistic knowledge of the cues, the position of these cues in the sentence does play a decisive role in successful processing. The position of the disambiguating cue, late in the sentence, and the consequent prolonged retention of the "agent-first strategy" have made it difficult for comprehenders to inhibit this strategy.

5.7 Conclusion

The present study has provided a picture of how L1 and L2 children make use in real time of case-marking when it aligns or conflicts with the "agent-first strategy" by testing participants with unambiguous OVS sentences in which the accusative case-marking was on the first NP and temporarily ambiguous OVS sentences in which the first NP was ambiguous and the second NP carried nominative case. At the same time, in line with previous studies investigating case-marking in competition with the "agent-first strategy", we measured participants' ultimate comprehension of the sentences.

Previous off-line studies conducted with unambiguous OVS sentences, with one exception (Schaner-Wolles, 1989), seem to agree that, between the ages of 5 and 7, L1 children learn to weight case-marking more heavily than the "agent-first strategy" (Biran & Ruigendijk, 2015; Dittmar et al., 2008; Schipke et al., 2012). L2 children who start to acquire the L2 around the age of 3 and 4 have been shown to perform more poorly than their L1 peers (Roesch & Chondrogianni, 2014). In the

present study, we were able to show that L1 children at age 7 were sensitive to the accusative case-marking on the first NP during processing even if during the off-line task their performance was merely around chance level. On the other hand, the L2 children revealed a far less pronounced reaction to the case-marking on-line and performed more poorly off-line as well. By contrast, when faced with temporarily ambiguous sentences, we found that both groups initially interpreted the sentences by making use of an "agent-first strategy" and were mostly incapable of revising that analysis when the conflicting case-marking came up during the second NP.

Overall, our findings show that both L1 and L2 children were neither at ceiling nor very low with unambiguous OVS sentences in their on-line comprehension (off-line performance was poorer). It would seem that, at age 7, children are still learning to rely on case-marking when it conflicts with the "agent-first strategy", as occurs in OVS sentences, and at the same time they are still learning to rely less on and/or inhibit the other expectation, namely the "agent-first strategy", because they have realized that the strategy is not always reliable. Broadly speaking, this suggests that in both L1 and L2 acquisition knowledge of a cue such as case-marking in isolation is a slow, gradual process which goes through intermediate stages before children can reach full competence and handle the cue in an adult-like fashion. Moreover, we would argue that the difficulties that L1 children have in maintaining the correct interpretation until the end of a sentence reflect the less developed working memory capacities that are characteristic of this age group as a whole.

In comparison to the L1 children, the L2 children performed poorer both on-line and off-line. For this group, we would argue that they are still in the midst of learning that case-marking can conflict with the "agent-first strategy" and that case-marking is more reliable than the "agent-first strategy". The L2 children are at a less advanced stage in the learning process than in the L1 children because the L2 children have had less overall exposure to the L2 and thus to the structure in question, and their proficiency in the L2 is lower in all respects than that of the L1 children. In line with Marinis's (2007) study, it is important to note that, despite showing sensitivity to case-marking during on-line comprehension, when asked to select the picture corresponding to the sentence, both groups prefer to make use of simpler heuristics, such as the "agent-first strategy". From the findings of experiment 4.2 we

conclude that the more sustained the reliance on a cue or expectation, the more difficult it is for the participants, independent of their language status, to not follow a garden-path strategy, that is, to revise their first flawed sentence interpretation.

For further studies, it would be interesting to replicate this experiment but this time add stress to the topicalized first NP in order to see whether this additional cue would diminish the impact of the "agent-first strategy" and elicit a more successful performance from participants. Furthermore, in the present study the L1 of the L2 children was Turkish, a language in which case-marking is a more valid cue than in German and which makes extensive use of subject-drop, while dropping the initial NP is less frequently possible in German. Contrary to the expectation that Turkish-German children, due to the properties of their L1, would have made less use of the "agent-first strategy", we found that the L2 children in this study seemed to have more trouble abandoning it than the L1 children. In order to better understand whether the use of this strategy is not motivated by the particular L1 of the learner but rather a property of less proficient language users in general perhaps because this strategy is simple and easy to apply (Marinis, 2007), it would be of interest to conduct follow-up studies with L2 children who have other L1s. One possibility would be Russian, in which case-marking is also highly disambiguating as in Turkish and word order is more flexible than in German.

6 Summary and Conclusions

In the present dissertation, we investigated the comprehension of two non-canonical German structures, passive and OVS sentences, from both a developmental and a multilingual perspective. Both structures are considered non-canonical because they deviate from the canonical ordering of thematic roles in German, namely agent before patient. In addition, the two structures differ from each other in terms of their ordering of syntactic functions. Passive sentences maintain the canonical distribution of SV*fin*O but are non-canonical in their mapping of subject to patient in the first NP. In OVS sentences, by contrast, while the subject/agent mapping is canonical, the ordering of syntactic functions is not, because the first NP is the object while the second NP is the subject.

Most studies with first and second language learners of German have documented that the comprehension of these sentences is more difficult than that of canonical sentences. Studies on learners of other languages point in the same direction. It therefore comes as no surprise that, in the literature on German didactics, the two structures are counted among the key stumbling blocks that children have to overcome in primary school in order to master the challenging task of text comprehension.

The first main objective of the present dissertation was to investigate overall oral comprehension of these structures, testing monolingual children and adults against second language children in order to determine whether the two groups revealed any differences in their ability to interpret the structures correctly off-line. The second objective was to analyse participants' real-time comprehension of the structures and thus obtain detailed insights into any possible differences in how the groups resolved the conflict between the expectation of a canonical sentence, characterized by the subject/agent-verb/action-object/patient ordering and mappings, and the competing cues of passive and OVS sentences as they unfold.

The accomplishment of these objectives makes this dissertation the first work so far to provide such a complete picture of how German monolingual and second language children comprehend non-canonical sentences in the course of their development by focusing on both off-line and on-line comprehension. To date,

studies comparing monolingual and second language child learners of German have focused exclusively on the children's off-line comprehension (e.g., for passives: Grimm, 1975; Mills, 1977, Root, 2014; Schneitz, 2015; for OVS sentences: Biran & Ruigendijk, 2015; Gamper, 2016; Lindner, 2003; Schaner-Wolles, 1989). Among them, only one to our knowledge (Grimm, 1975) has investigated children's comprehension from a developmental perspective by exploring the off-line performance of more than one age group. As for on-line comprehension, although a few studies involving adults have been carried out (e.g., Knoeferle et al., 2005; Weber et al., 2006; Wendt et al., 2014), to our knowledge no previous study for German has focused on the question of how children process non-canonical sentences in real time, providing a window into whether and how participants exploit the cues identifying the non-canonical structures as they hear them. Therefore the present investigation of processing strategies from a developmental perspective is a novel contribution to not only research into the acquisition of German but also child language processing research in general. The only study to our knowledge presenting a similar research question and experimental design is that by Stromswold (under review), who tested more than one age group, namely monolingual English children at ages 5 and 6, by monitoring their eye gaze movements and their final comprehension of passive structures through a picture-matching task. In the field of child second language processing, the existing studies have been conducted with other learning populations than the German-Turkish one examined here (e.g., Marinis, 2007: 7-year-old monolingual English and second language English-Turkish children) and using other on-line methods, such as self-paced listening. In self-paced listening studies, longer participant reaction times are assumed to indicate a greater level of difficulty in processing. By contrast, in the present study we monitored participant eye gaze movements to capture their processing interpretations, that is, to determine whether and how they made on-line use of the cues identifying the structures under investigation. Overall studies monitoring the eye movements of second language learners and in particular second language children who did not start to acquire the two languages simultaneously are very rare. With regard to adults learning German as a second language, a number of studies are available (e.g., Hopp, 2006; 2010; Jackson & Roberts, 2010), and research with child second language

learners has also been starting to grow in the last few years. However, this dissertation is the first work to explore the differences in the processing mechanisms between monolingual learners and second language learners who started to acquire German as a second language in their third or fourth year of life.

In order to investigate these questions, we conducted four studies, two studies focusing on a developmental perspective and two on a multilingual perspective. Each perspective included one study in which participants were tested on passive sentences and another which examined their processing of OVS sentences.

As described in detail above, two different experimental methods were applied in this dissertation. On the one hand, we tested participants on a sentence-picture matching task in which they were instructed to select which of two pictures on the screen depicted the meaning of the sentence they had heard. These data provided us with participants' ultimate interpretation of the sentence, that is, their off-line interpretation. At the same time, we tracked their eye movements directed at the two pictures as they were listening to the sentence, thus gaining insights into their on-line interpretation. In our analysis of this on-line data we focused on the time after the onset of the specific cues that disambiguated the sentences as either canonical or non-canonical. Specifically, we investigated whether participants started out by interpreting all the sentences as if they were canonical, thus relying on the strategy, which we have labelled "agent-first strategy". This preference during non-canonical sentences would misdirect participants towards an incorrect interpretation of the sentence. Moreover, we focused our attention on the specific morphosyntactic cues marking canonical and non-canonical sentences, such as the respective auxiliaries, second NPs and past participles. Doing this enabled us to investigate whether, specifically after the onset of a disambiguating cue, participants' eye movements were directed more to the target or the competitor picture. When the number of fixations directed at the target picture exceeded those directed at the competitor picture or began to increase relatively, we interpreted that as evidence that participants were correctly exploiting the disambiguating cue during on-line processing. In addition to whether participants reacted to the cues or not, we also examined the intensity of this reaction by considering the percentage of target fixations and the point in time when participants started to correctly exploit the cue.

The four studies

Study (Exp.)	Structure	Participant groups	Perspective
1 (1)	passive	L1 7-year-olds, L1 10-year-olds, L1 adults	developmental
2 (2.1,2.2)	passive	L1 and L2 7-year-olds L1 and L2 10-year-olds	multilingual
3 (3.1,3.2)	OVS unambiguous & temp. ambiguous	L1 7-year-olds, L1 adults	developmental
4 (4.1,4.2)	OVS unambiguous & temp. ambiguous	L1 7-year-olds, L2 7-year-olds	multilingual

Research questions

Throughout this study, the following research questions have been addressed:

Off-line interpretations:

(1) Do participants interpret non-canonical sentences correctly in the off-line task?

On-line interpretations:

(2) How do participants process non-canonical sentences on-line?

(2a) Do they react according to an "agent-first strategy"?

(2b) Do they react to the cues marking non-canonical sentences?

(2c) Are there differences with respect to (2a) and (2b) in terms of timing and reaction intensity?

Relation between on-line and off-line preferences

(3) How close is the relation between on-line processing and final judgements?

(3a) When a group exhibits high accuracy in off-line judgements, will they also do so in on-line processing?

(3b) When a group misinterprets non-canonical sentences, will they nevertheless react to the relevant cues on-line? If so, to what degree and how quickly?

Depending on participants' off-line interpretation of the different target structures, for research question (3) either sub-question (3a) or sub-question (3b) will become relevant. In each study, our analysis will therefore focus on only one or the other of these sub-questions.

Moreover, despite the fact that we explored the comprehension of both canonical and non-canonical sentences, our focus is on non-canonical sentences, with canonical sentences used as our control condition. For this reason, in answering the above research questions, we have focused exclusively on passive and OVS sentences without commenting on the corresponding control condition, that is, active and SVO sentences, where performance results were at ceiling, as would be expected.

In the following we answer the research questions in detail for each of the four studies.

6.1 Study 1 (chapter 2): passive sentences from a developmental perspective, L1 7-year-olds, 10-year-olds and adults

Off-line interpretations:

(1) Do participants interpret non-canonical sentences correctly in the off-line task?

All three groups interpreted passive sentences correctly, achieving ceiling accuracy, and showed no differences in their off-line results.

On-line interpretations:

(2) How do participants process non-canonical sentences on-line?

(2a) Do they react according to an "agent-first strategy"?

(2b) Do they react to the cues marking non-canonical sentences?

(2c) Are there differences with respect to (2a) and (2b) in terms of timing and reaction intensity?

(2a) All three groups started out by processing the sentences according to an "agent-first strategy", thus assuming that the first NP was the agent of the action.
(2b) With the onset of the first passive disambiguating cue, the auxiliary *wurde*, all groups revealed on-line sensitivity to it, that is they were able to abandon the "agent-first strategy", which would have led them to an overall incorrect interpretation of the sentence.
(2c) The "agent-first strategy" was more pronounced in the 7-year-olds than in the 10-year-olds and least pronounced in the adults. The intensity of this strategy, that is, the degree to which participants looked at the wrong picture, seems to correlate inversely with how quickly they abandoned this strategy and/or reacted to the passive auxiliary. Crucially, the 7-year-olds, who relied mostly heavily on it, started later to revise their initial misanalysis and/or showed a later reaction to the passive auxiliary *wurde*. The 10-year-olds were faster than the 7-year-olds in giving up the "agent-first strategy" but slower than the adults. Concerning the degree of exploitation of the passive cues, there were no differences between the groups, meaning that despite the different integration times of the auxiliary, the groups exploited it to the same extent before the onset of the second passive cue.

Relation between on-line and off-line preferences

(3) How close is the relation between on-line processing and final judgements?

Since participants almost always selected the correct picture, we focused on research question (3a):

(3a) When a group exhibits high accuracy in off-line judgements, will they also do so in on-line processing?

In order to answer sub-question (3a), we conducted an analysis of the on-line data considering participants' eye gaze movements only for those trials in which they provided a correct answer. This enabled us to determine whether, though they had

achieved identical final scores, the three groups actually followed different paths to end up there.

If we compare the percentages of fixations at the target picture in all three groups at their maximum level during on-line processing with the percentages of their off-line scores, we found no differences. The only difference between the groups that emerged from the investigation of their processing and not from their final scores concerned the timing of their reaction to the first passive cue.

Interpretation

Despite all groups' high off-line performance, the on-line data point to differences between groups that we would have ignored had we limited our methodology to off-line data alone. We interpreted the more pronounced "agent-first strategy" emerging from the on-line data together with its prolonged use as the results of a learning process. We argued that this process consists in learning in the course of development to assign less value to the "agent-first strategy", which is not always reliable, and to assign greater weight to more reliable cues such as the auxiliary *wurde*.

Alongside this experience-based learning interpretation, we also argued that this more pronounced use of the "agent-first strategy" together with its later abandoning emerging in the child analysis to be affected by the less developed executive functions of the younger learners. Specifically, a less mature inhibitory control system made it more difficult for the youngest participants to inhibit "irrelevant" cues. Under this line of reasoning, the first strategy participants seem to exploit is the "agent-first strategy", an "irrelevant" or overall less reliable interpretation in the case of passives because it leads participants to a wrong interpretation. With the onset of the passive auxiliary, a cue in competition with the "agent-first strategy" and more "relevant" as it indicates passives[46], we found that the adults were able to quickly inhibit their initial reliance on the "agent-first strategy" and quickly and robustly exploit the new information. On the other hand, we found that children needed more time to carry out this corrective action due to – we would argue – their less developed inhibitory capacities.

[46] The passive auxiliary *wurde* can also be interpreted as a copula. However, the visual setting displaying an action involving an agent and a patient does not favour this interpretation.

Both interpretations – the first experience-based, according to which the reason for the 7-year-olds' slower integration of the passive auxiliary is related to a still incomplete acquisition of cue validity, and the second, related to age and cognitive maturation, whereby the slower integration is due to a less developed inhibitory control – would seem to be plausible to explain the pattern we found.

However, the fact that the 7-year-olds in the off-line task performed almost at ceiling speaks less in favour of the argument that the children have less linguistic knowledge of the passive morphosyntax than the older children and more in favour of the argument claiming less mature inhibitory control abilities at age 7.

Alternatively, it might be the case that in the 7-year-olds linguistic knowledge of passives is not as entrenched and consolidated as it is in the 10-year-olds, resulting in a later reaction to the relevant cue, despite the high off-line performance.

In order to disentangle the two explanations and better understand the role played by executive functions during sentence processing, we suggest that further studies on on-line comprehension are essential to collect information on participants' executive function capacities. Such studies would enable us to detect whether there exist any correlations between children's inhibitory capacities and the speed with which they abandon linguistically irrelevant cues. If these correlations are shown to exist, it would mean that in order to fully explain sentence comprehension we need a model that considers both linguistic knowledge and non-linguistic capacities together.

6.2 Study 2 (chapter 3): passive sentences from a multilingual perspective, L1 and L2 7- and 10-year-olds

Off-line interpretations:

(1) Do participants interpret non-canonical sentences correctly in the off-line task?

The L1 and L2 10-year-olds interpreted passive sentences correctly most of the time and statistically did not differ from each other in this respect. By contrast, a difference of 13% was found between the L1 and L2 7-year-olds in terms of their accuracy scores.

On-line interpretations:

(2) How do participants process non-canonical sentences on-line?
   (2a) Do they react according to an "agent-first strategy"?
   (2b) Do they react to the cues marking non-canonical sentences?
   (2c) Are there differences with respect to (2a) and (2b) in terms of timing and reaction intensity?

(2a) All groups started out by interpreting the sentences with the "agent-first strategy".
(2b) With the onset of the conflicting passive auxiliary *wurde*, all four groups were able to repress this strategy and begin to exploit the passive cue on-line.
(2c) The "agent-first strategy" was slightly more pronounced in the L2 than in the L1 10-year-olds. However, between the 10-year-old groups, we detected no differences in the timing of their integration of the passive auxiliary, as the groups reacted to it at the same point in time. Moreover, the degree to which the auxiliary was exploited did not differ across groups, with both groups reaching the same percentage of fixations after the onset of the cue. On the other hand, the picture provided by the 7-year-olds is quite different as we found differences in the timing of their revision of the "agent-first strategy" – which was at first similarly pronounced – and/or reaction to *wurde.* The L2 7-year-olds reacted to the auxiliary later than the L1 children and were slower to reach the same level of target fixations. Specifically, with the onset of the second passive cue, the *von*-phrase, target fixations of the L2 7-year-olds were still around

chance and it was not until almost the end of the sentences that they reached the same degree of target fixations during passives as the L1 children.

Relation between on-line and off-line preferences

(3) How close is the relation between on-line processing and final judgements?

(3a) When a group exhibits high accuracy in off-line judgements, will they also do so in on-line processing?

In order to answer sub-question (3a), we conducted the same selective analysis of the data described for the previous study, considering only those trials in which participants provided a correct answer. L1 and L2 10-year-olds revealed a comparable intensity of reliance on the passive morphosyntax as in the off-line scores, with both groups integrating the cue at the same time. For the L1 and L2 7-year-olds we found a similar pattern, namely no difference between the on-line and off-line reliance on the passive cues. However, we detected differences between the 7-year-olds concerning the moment in the sentences at which they started to correctly exploit the passive cues as well as the moment in the sentences at which they exploited the cues with the same intensity, both moments occurring later for the L2 children.

Interpretation

These findings together suggest that even if the L2 7-year-olds' off-line performance was high and not significantly different from that of the L1 age-matched children, their on-line use of the cues was still not native-like, in contrast to the older L2 10-year-olds compared to their L1 peers. We interpreted these results in view of the shorter cumulative exposure time of the L2 7-year-olds to German, which at age 7 was around 3-4 years. Specifically, we argued that the L2 7-year-olds are still learning how to weight cues in a native-like fashion and the time they had at their disposal to extract information from the input was still too short. The fact that we found that the L2 10-year-olds did not differ from their L1 peers confirms our hypothesis that the longer exposure to the L2, the more native-like the children's processing becomes. This would seem to be the most plausible explanation for these

findings even if we cannot completely exclude the possibility that underdeveloped executive functions might also have played a role. If study 1, viewed from a developmental perspective, seems to confirm the findings of several other studies that adults have overall more developed executive functions than children this does nothing to account for differences observed between age-matched monolingual and second language children. More precisely, there is no reason why child second language learners might have more strained cognitive resources and therefore greater difficulty than the L1 children with the task of inhibition. On the contrary, according to previous studies, we should rather expect more developed inhibitory competences in L2 than L1 children. Previous research has showed that the managing of two lingusitic systems has positive effects on executive functions, such as inhibitory abilities (Bialystok et al., 2004; Bialystok & Craik 2010; Hilchey & Klein, 2011; Poarch & van Hell, 2012) and potentially on sentence revision as well (Huang et al., 2013; Huang et al., 2016; Novick et al., 2013).

In the same vein as what we noted regarding study 1, further studies on child sentence processing are needed to collect data on participants' executive functions and explore whether there are correlations between linguistic processing and cognitive functions.

In sum, similarly to the previous study with monolingual children and adults, a comparative analysis of on-line data from L1 and L2 10- and 7-year-olds informs us that despite achieving the same final comprehension of the sentences, learners differ from native speakers in how and when they apply their knowledge during online processing. We would argue that these differences depend in large part on differences in how the groups weight cues.

6.3 Study 3 (chapter 4): OVS sentences from a developmental perspective, L1 7-year-olds and adults

Off-line interpretations:

(1) Do participants interpret non-canonical sentences correctly in the off-line task?

Participants were tested with two types of OVS sentences, unambiguous and temporarily ambiguous OVS sentences. The first type included an accusative masculine first NP, which immediately disambiguated the sentence as an OVS, whereas the second type presented a first accusative feminine NP, which left the sentence ambiguous until the onset of the second nominative masculine NP. Overall comprehension by the 7-year-olds was poor. More precisely, during unambiguous OVS sentences, the 7-year-olds only performed at chance level whereas the adults revealed ceiling accuracy. During temporarily ambiguous OVS sentences, adults performed at chance and the children were very low.

On-line interpretations:

(2) How do participants process non-canonical sentences on-line?

(2a) Do they react according to an "agent-first strategy"?

(2b) Do they react to the cues marking non-canonical sentences?

(2c) Are there differences with respect to (2a) and (2b) in terms of timing and reaction intensity?

(2a) During unambiguous OVS-sentences we found that adults did not make use of an "agent-first strategy" as their rate of gazes at the correct picture was never below chance. In the children's data, we also did not find clearcut use of this strategy as target fixations were as well above chance from the start. During temporarily ambiguous sentences, the on-line data demonstrated that both groups started out interpreting sentences according to an "agent-first strategy", initially regarding the first (ambiguous feminine) NP as the subject/agent.

(2b) Both groups revealed sensitivity to the accusative marking *den* on the first NP in unambiguous OVS sentences. During temporarily ambiguous sentences, both groups revealed sensitivity to the nominative marking *der* on the second NP.

(2c) During unambiguous OVS sentences, the 7-year-olds directed 75% of their fixations at the target picture at their maximum level of reliance on the accusative cue. This contrasts with the behaviour seen in the adults, who directed 95% of their gazes at the target picture. The 7-year-olds also reacted later to the accusative cue than the adults: while the adults increased their gazes at the target picture immediately after the processing of the cues, the children did not really seem to react before the onset of the second NP, and it was not until almost the end of the sentence that their reaction occurred. One interpretation for this later reaction to the accusative marker on the part of the children might be that the children were sensitive to the accusative cue but, unlike the adults, did not rely on it to such a degree as to lead them to immediately react to it. It seems rather that the children preferred to wait until the second NP in order to see whether the second NP was compatible with a possible non-canonical interpretation of the sentence and only after this point reacted to the cue. Furthermore, it might be the case that the children from the beginning entertained two rival interpretations of the sentence, a canonical and a non-canonical one, and that they made their final decision only after they had more material at disposal to disambiguate the sentence. From an executive point of view, this task must be highly complex for the children. First, their working memory is strained as they have to keep in mind two interpretations in parallel. Second, due to the previous findings showing that children rely heavily on the "agent-first strategy", it might be the case that in addition to maintaining the parallel interpretations they also face the extra task of inhibiting the strategy they are inclined to rely on most, namely the "agent-first strategy". Importantly, in the last part of the sentence, the children's scores went back to chance level, showing that they had ceased to interpret the sentence correctly.

During temporarily ambiguous OVS sentences, the "agent-first strategy"– which we found in both groups – was more pronounced in the children than in the adults. In addition, the adults showed a more pronounced on-line reaction to the disambiguating cue during the second NP than did the children. Similarly to the passive study (study 2), we observed that the stronger the reliance on the "agent-first strategy", the more difficult it was for participants to abandon this strategy when the disambiguating cue *der* (nominative) on the second NP intervened. Specifically, with

the onset of the cue, children's fixations to the target picture increased by 10% while the adults' fixations increased by 35%. These scores indicate that abandonment of the "agent-first strategy" was minimal for the children but more pronounced for the adults.

Relation between on-line and off-line preferences

(3) How close is the relation between on-line processing and final judgements?

(3b) When a group misinterprets non-canonical sentences, will they nevertheless react to the relevant cues on-line? If so, to what degree and how quickly?

Unlike what we saw in the two studies on passives, in the studies on OVS sentences overall comprehension was poor, so we will focus on sub-question (3b). As a result, our analysis differs from that applied in the previous two studies because we will include all available data rather than limiting ourselves only to trials with correct answers. By including all trials in the analysis, we asked whether, despite the low off-line scores, participants were in fact sensitive to the cues during on-line comprehension. If this were true, that is, if the data demonstrated that participants were sensitive to the cues on-line, it would constitute evidence that participants have some relevant linguistic knowledge even if they do not make use of it for their final interpretation of the sentences.[47]

Despite the low off-line results of the 7-year-olds, analysis of the children' eye gaze data demonstrates that they did make use of the accusative marking *den* on the first NP. However, by the end of the sentences, they had stopped relying on the cue and gone back to chance level, as if they were no longer able to hold the correct interpretation in their memory. During temporarily ambiguous sentences, we were able to show that both the adults and the 7-year-olds were slightly better on-line than off-line, meaning that they recognized the disambiguating marker on the second NP

[47] This is the way we analysed the present data. However, other analyses are possible, such as an analysis of eye movement data for incorrect trials only. In this case, the research question would have to have been different, focusing instead on how children exploit the cues when they misinterpret sentences and whether some linguistic knowledge can be detected in the on-line processing. In the current study, by contrast, we wanted to have a comprehensive picture of children's knowledge of OVS sentences, and we therefore analysed all data, for both correct and incorrect trials.

and attempted to revise their initial incorrect commitment. However, in the end the children did not achieve significantly higher results on-line than off-line.

Interpretation

Taken together, these findings demonstrate that the L1 7-year-olds experienced difficulties off-line with both type of OVS sentences, whether unambiguous or temporarily ambiguous. The investigation of their eye gaze movements shows, however, that during unambiguous OVS sentences the children were sensitive to the accusative case-marking during the first NP, albeit exploiting it properly at a later point in the sentence than the adults. By the end of the sentence and in the off-line task, they were no longer able to hold onto the correct analysis and thus performed both on-line and off-line at chance. We interpreted these findings as showing that the children correctly understood unambiguous OVS sentences on-line, that is, they recognized that the first NP was not the agent, even if off-line their performance was merely at chance, because they preferred to make use of simple heuristics to interpret the sentences as being canonical. The fact that the children waited until the second NP, to get a confirmimation cue that the first NP can be the object and then start interpreting the sentence as OVS, trying to keep this analysis to the end makes these sentences highly challenging from an executive function point of view. Children reacted later than the adults to the accusative cue because they preferred to wait for a second confirming cue before committing themselves to a decision. Furthermore, we also argued that since the children were not fully convinced that the first cue marked the sentence as non-canonical, they therefore held onto both possible interpretations, canonical and non-canonical, until they could decide whether the non-canonical interpretation was compatible with the second NP. This processing pattern requires high working memory skills and inhibitory control – high working memory capacities to manage the load of maintaining two interpretations in parallel and inhibitory control in order to keep inhibiting the more frequent "agent-first strategy". In the end, the cognitive burden was too great for the children since they could not hold onto the correct interpretation until the end of the sentence, making the explanation from an executive perspective highly plausible. However, even if we argue that unambiguous

OVS sentences are challenging from an executive point of view, this does not mean that missing knowledge about the cues does not play any role at all. If this were the case, namely if the children had been absolutely sure that the article *den* marked an object, then they would probably not have needed to wait until the second NP to make a decision and would instead have reacted to the cue immediately, as the adults did. In sum, the fact that on-line the children revealed knowledge of the cues and structure but off-line could not integrate all this information to interpret the sentences correctly suggests that the difficulty of this structure is more a matter of juggling and integrating cues and strategies simultaneously than linguistic knowledge per se.

By contrast, during temporarily ambiguous sentences the behaviour of the 7-year-olds and the adults was highly similar. Both groups had difficulty abandoning their initial interpretation of the sentence based on the "agent-first strategy" once the disambiguating OVS cue intervened. In this case, we interpreted the findings as highlighting the role of the cues' position in the sentence. It seems that for both groups the later the cues appear in the sentence, the longer the ambiguous region and the more difficult it is to abandon initial commitments. Differently to unambiguous OVS sentences, in this condition both groups committed themselves to a strategy from the beginning and neither of the groups waited for another cue, thereby leaving the option open that the ambiguous NP introduced by the article *die* might also indicate a non-canonical sentence. Interestingly, we found that adults reacted to the disambiguating NP in second position, which from a pragmatic perspective is odd in only 50% of the cases. The children had far more difficulty with the cue in that position, and although there seems to have been some recognition of it, it was not sufficient to inhibit their initial strategy. Hence, we conclude that this last structure required for its understanding both linguistic knowledge of the pragmatically unmotivated cue as well as inhibitory capacities. For further studies, in order to explore the role of cue positioning, it would be important to test reactions to sentences that were more contextually situated and rendered more natural by marking them with intonation in order to rule out the possibility that subjects struggle to understand them simply because they seem odd.

6.4 Study 4 (chapter 5): OVS sentences from a multilingual perspective, L1 and L2 7-year-olds

Off-line interpretations:

(1) Do participants interpret non-canonical sentences correctly in the off-line task?

During unambiguous OVS sentences, the L1 children performed at chance whereas the L2 children achieved very low off-line scores. With temporarily ambiguous OVS sentences, both L1 and L2 children performed very poorly, indicating that they mostly misinterpreted this type of OVS sentence.

On-line interpretations:

(2) How do participants process non-canonical sentences on-line?
   (2a) Do they react according to an "agent-first strategy"?
   (2b) Do they react to the cues marking non-canonical sentences?
   (2c) Are there differences with respect to (2a) and (2b) in terms of timing and reaction intensity?

(2a) During unambiguous sentences, a proper "agent-first strategy" can be observed in the L2 children but not in the L1 children. During temporarily ambiguous OVS sentences, both groups started out by interpreting the sentences using an "agent-first strategy".

(2b) During unambiguous OVS sentences, both L1 and L2 children descriptively revealed sensitivity to the accusative case-marking during the first NP. During temporarily ambiguous OVS sentences, with the onset of the disambiguating nominative marking on the second NP, the groups descriptively revealed sensitivity to this cue.

(2c) During unambiguous OVS sentences, concerning the "agent-first strategy" the L1 7-year-olds relied on it less than 50% of the time whereas the L2 children relied on it more than 50% of the time, making this reliance more robust in the latter group. The fact that the L1 7-year-olds did not make strong use of the "agent-first strategy" indicates that they were sensitive to the accusative first NP right at its onset, but reacted to it properly only later in the sentence, after the onset of the second NP but

before the end of the sentence. At the maximum point of cue exploitation, the L1 children revealed 75% target fixations. On the other hand, the L2 children relied much more heavily on the "agent-first strategy", as if they did not notice that the first NP was not marked for nominative. However, since fixations to the competitor picture were not as frequent as fixations to the target picture during canonical sentences, we concluded that they exploited the case-marking cue to a certain degree, albeit very weakly. During temporarily ambiguous sentences, no differences between the groups can be observed. The very slight increase in target fixations almost at the end of the OVS sentences took place at the same time for both groups and might indicate an attempt to react to the cue, even though neither of the groups proved capable of using it to revise their initial wrong commitment.

Relation between on-line and off-line preferences

(3) How close is the relation between on-line processing and final judgements?

> (3b) When a group misinterprets non-canonical sentences, will they nevertheless react to the relevant cues on-line? If so, to what degree and how quickly?

The same analysis as in study 3 was conducted. During unambiguous OVS sentences, both groups were shown to perform better on-line than off-line, that is, to look more at the correct picture in the on-line task than they performed in the off-line task. We found that both child groups were sensitive to the cue but by the end of the sentences were not able to maintain the correct interpretation. In particular, from a target fixation score at 75%, the L1 children went back to chance level, whereas the difference between on-line and off-line scores for the L2 children was smaller, with the final off-line score below chance level. During temporarily ambiguous sentences, the reaction to the cue was minimal in both groups.

Interpretation

Taken together, these findings indicate that despite the poor off-line performance of both groups with both type of OVS sentences, participants used the disambiguating cues to a certain extent during on-line processing. Importantly, during unambiguous

sentences, the L1 children relied on case-marking more heavily and earlier than the L2 children. While we argued in our analysis of study 3 that the behaviour of the L1 children might plausibly be determined by their less developed executive functions, it seems that this explanation is less persuasive for explaining the data of the L2 children. Specifically, while we found that the L1 children reacted to the accusative NP as seen by their on-line target fixation score of 75%, this was not the case for the L2 children. The L2 children were shown to never have a stronger preference for the target than the competitor picture during OVS sentences. They relied heavily on the the "agent-first strategy" and descriptively revealed to increase target looks almost at the same time as the L1 children, but with less intensity, and still directed more gazes overall at the competitor picture. This finding suggests that their linguistic knowledge that the accusative cue *den* introduces an accusative NP and that the "agent-first strategy" is not a reliable processing preference is less firmly consolidated than in the L1 children. Moreover, the difference in off-line vs. on-line performance in the L2 children was not as pronounced as it was for the L1 children, meaning that difficulty in the L2 children's final comprehension was not due to a problem in executive functions, but rather to a lack of linguistic knowledge. In sum, we cannot completely rule out the idea that executive functions might have played a role in the L2 children's low performance, but again in view of the smaller gap between off-line and on-line performance, we can argue that this is not the main reason. In future research, in order to see how executive functions affect L2 children's comprehension, it would be of interest to test older L2 children with only 3-4 years of exposure to German like the children in this study. By controlling for language knowledge in this way, if the performance of the older children proved to be superior to the one that emerged with the present L2 7-year-olds, it would confirm that executive function plays a role in the processing of OVS sentences since it is a faculty that presumably becomes more fully developed with age.

In the case of temporarily ambiguous OVS sentences, both groups interpreted the sentences according to an "agent-first strategy", showed a minimal, weak reaction to the disambiguating nominative cue and misinterpreted the sentences in almost all instances.

As we argued in our analysis of study 3, the fact that the sentences in all four studies are pragmatically unnatural and that in this particular case, even adults misunderstood them makes it difficult to clearly pinpoint the reason for their misunderstanding. As we suggested in our analysis of the previous study, for further studies in sentence processing, in order to investigate how the position of the disambiguating cue in the sentence affects comprehension, it might be helpful to make use of less artificial sentences.

6.5 Differences between the groups in their processing mechanisms

6.5.1 From a developmental perspective

L1 children and adults (studies 1 & 3)

In the two studies focusing on a developmental perspective (studies 1 and 3), we investigated and compared sentence comprehension between monolingual children and adults. The groups are similar because both started to learn the L1 from birth and only differ with respect to their age at the time of testing. The different ages of the two groups imply differences in the length of exposure to the language, meaning language proficiency, and cognitive maturity. In terms of language proficiency, we can assume that by age 7 the younger group has already acquired most of the German morphosyntax. By cognitive maturity in this study we refer specifically to two capacities included under the term executive function, namely working memory and inhibitory control. These abilities have been shown to reach full development in early adulthood (e.g., Davidson et al., 2006) and also to affect sentence processing. In particular, a less developed working memory has been shown to affect participants' ability to take more than one cue into consideration during processing (Snedeker & Trueswell, 2004; Trueswell et al., 1999) and then integrate all of the cues at the end of the sentence in order to yield meaning (Adani & Fritzsche, 2015; Bahlmann et al., 2007; Huang et al., 2013; Marinis, 2007). On the other hand, inhibitory control concerns participants' ability to override irrelevant cues during processing in order to react more robustly to more relevant cues. In this context, studies comparing adults and 5-year-olds have shown that while adults are mostly successful in recovering from syntactic misanalyses, 5-year-old children, due to their less developed inhibitory abilities, have been shown unable to do so (Huang et al., 2016; Novick et al., 2013; Trueswell et al., 1999).

Gradual on-line reliance on the most valid cues

The analysis of children and adults' eye gaze movements in the two studies informs us that children at age 7 can take into consideration the same cues as adults.

Importantly, the present dissertation provides new findings for language acquisition research from a processing perspective, since this is the first study using on-line data to show how the reliance on cues varies over age, in a continuum from age 7 to age 10 to adulthood. We revealed that reliance on the most valid cues, namely the passive morphosyntactic cues or case-marking for OVS sentences, which must be weighted more heavily than the "agent-first strategy" in order to correctly interpret sentences, gradually increased as the children got older. By the same token, we were also able to show that the use of the more frequent, but less valid "agent-first strategy" was most heavily exploited by the younger child group, the 7-year-olds, and reliance on it diminished gradually as the children got older. The use of this strategy appears to be a computationally inexpensive heuristic that children make intense use of in the earliest stages of comprehension. Over development, they gradually abandon this preference as they become more proficient with the language and consequently learn to know that this strategy is not 100% reliable and can sometimes lead to garden-path effects. Moreover, we were able to demonstrate that the less participants rely on the "agent-first strategy", the easier it is for them to give up this preference and the better they can exploit the other morphosyntactic cues that are in competition with it.

Passive morphosyntax (study 1) vs. case-marking (study 3)

We found that, overall, OVS sentences were for the children much more difficult to understand than passive sentences and that temporarily ambiguous OVS sentences were misunderstood by both children and adults.

During unambiguous OVS sentences, even if we found that children were sensitive to the accusative case-marking cue and for a time interpreted the sentence correctly, by the end of the sentence they were no longer able to retain the correct interpretation and their performance ended up being merely at chance level. This sharp gap between on-line and off-line performance is not seen in the passive study (study 1), in which we found that children were highly successful both on-line and off-line. During passives, we found that the groups reacted to the passive morphosyntax flawlessly, thereby abandoning the wrong initial commitment based on the "agent-first strategy" and succeeded in maintaining the correct sentence reanalysis until the end of the sentence. Taken as a whole, these findings raise the question as to

why the children ultimately had more difficulty understanding OVS sentences than passives and at the same time why we find a larger on-line/off-line gap during OVS than during passive sentences.

In passive sentences, the first NP is the subject and patient of the action, while in OVS sentences it is the object and patient. From a syntactic perspective, passive sentences present the linear ordering of the syntactic functions whereas OVS sentences do not. As a consequence, during passives, participants can potentially already construct a syntactic representation of the sentence as soon as they encounter the verb, the auxiliary *wurde*. The complexity with passives is to reanalyse the sentences from a semantic perspective, assigning thus the role of patient and not agent to the first NP. This reanalysis does not seem to challenge children too much, given that we were able to demonstrate that after the onset of *wurde* they started to revise their initial wrong commitment, albeit more slowly than the adults. On the other hand, during unambiguous OVS sentences, participants are faced with an unambiguously marked object. This means that even if they have correctly recognized that the first NP is not the subject, the following auxiliary *hat* does not bear any lexical information which would help them to further disambiguate the first NP as object and patient. The onset of the subject, the second feminine NP is in coalition with the interpretation of the first NP as object of the sentence because, being ambiguous, it does not offer any cue against the interpretation of the first NP as patient. Even though the second NP is not 100% reliable, as *die* can be either nominative or accusative, once participants have recognized the initial NP as accusative, they can then use the second NP as a confirming cue. The data are compatible with this hypothesis, as we found that children did not start to interpret OVS sentences correctly until they had processed the second NP. They were sensitive to *den* from the beginning and thus reluctant to make use of an "agent-first strategy", but a full reaction to the cue took place only later. This behaviour of waiting for the subject in order to check whether the second NP is in line and supports the interpretation of the first NP as object is not a less demanding task from a cognitive perspective, but at the same time it is not an entirely unfamiliar one for children. From quite early on, L1 German children are presented with German sentences in which the first position is occupied not by the subject but rather by another

constituent like an adverb, such as in *Gestern hat die Oma lange gemalt* "Yesterday has the grandma for a long time painted". In this sentence, the subject slides into third position because German is a V2 language in which the finite verb obligatorily occupies the second position. In order to properly interpret the inversion in the above sentence, the child, after the onset of the adverb and the finite verb, has to wait for the subject the verb agrees with. Hence inversions require the same principle of waiting as seen in OVS sentences. However, the task for the child during inversions is less demanding than during OVS sentences. In sentences including inversions there is no competing NP that could potentially be the subject and as soon as the listener has encountered the subject in third position, he or she can start applying the "agent-first strategy".

Importantly, the present data show that the children waited for another cue, were then mostly able to exploit correctly the sentences, but finally interpreted the sentences as if they were canonical. The fact that in the end they came back to the canonical interpretation might indicate that throughout the course of the sentences they never completely abandoned the possibility that the sentences could be also canonical. Specifically, we argued during the "waiting" period that participants might have held both interpretations in reserve until the second NP. This task is particularly effortful for the working memory because it requires the maintaining of two competing interpretations until a certain point. In addition, given that previous studies showed that children made frequent use of an "agent-first strategy", it might also be the case that their inhibitory control was also overtaxed, thus allowing the simpler and less costly strategy to prevail.

From this picture illustrating how differently children processed unambiguous OVS and passive sentences and especially how their off-line and on-line performance diverged more markedly in the OVS study than in the passive, it seems plausible to conclude that executive functions play a stronger role when participants are asked to process OVS sentences than passives. Because we found that L1 children actually did have linguistic knowledge given that they exploited the cues on-line, it seems plausible that a deficit in their executive functions might be preventing them from making proper use of this knowledge, a competence that adults with a more developed executive function system have long since mastered. On the other hand,

during passives, it seems rather that the smaller differences we found between the groups are more likely due to a different weighting of the linguistic cues, due to a less consolidated and entrenched knowledge in the 7-year-olds.

Temporarily ambiguous OVS sentences present an interesting case, since they were poorly understood by the adults as well. However, as we argued above, the sentences were pragmatically very odd and the reason why all of the groups had difficulty integrating the disambiguating cue in final position might lie in the structure itself. We speculate that it might even be the case that participants found the nominative-marked second NP so odd in that position that they considered it as an error.

Moreover, alongside the above explanation there might be two other factors that lead to make unambiguous OVS sentences more difficult to process than passives. The only clearly disambiguating cue in unambiguous OVS sentence is the accusative case-marking *den*. Relative to the nominative marking *der*, *den* is not very salient, especially if compared to the auxiliary *wurde*. Importantly, we argue that if children have overheard *den*, the probability that they will fail to understand unambiguous OVS sentence is fairly high because the second feminine NP is ambiguous and potentially could also be interpreted as an accusative cue. Hence, only if participants have correctly recognized the first NP as an accusative can they afterwards interpret the second NP as a nominative, thus making use of it as confirmation that the first NP is an object. On the other hand, passives have relatively more and clearer cues, namely *wurde* and also the *by*-phrase. Hence, alongside cue validity, it seems proper to consider cue *saliency* as well when explaining subjects´ exploitation of cues.

Second, OVS sentences need stronger contextual embedding and prosodic marking than passive sentences. Specifically, even if rarely, both in texts as well as in naturally occurring spoken language passive sentences can be encountered in isolation, that is, as first sentences without any reference to previous sentences. This is not the case for OVS sentences, as the position of the object in first position has a pragmatic value, indicating a specific information structure, namely the intention of the speaker and/or writer to highlight the object that is not new information in the context and/or discourse. Hence, the fact that in the present study OVS sentences

were produced in isolation might have made their comprehension more difficult. It is also important to note that in naturally occurring spoken language, the first NP in OVS sentences can bear pitch accent, a cue that we did not consider in the present study. In German the default pitch accent is on the last argument and in order to prosodically mark non-canonical sentences, speakers can mark the first NP with pitch accent. A previous study with OVS sentences revealed that adults were affected by the prosodic cue (Weber et al., 2006) on the first NP of OVS sentences, making their comprehension easier. Against this background, the fact that OVS sentences were mostly misunderstood might have been due to the lack of proper intonation in the recordings of the sentences.

To conclude this section, concerning children's knowledge of passive and OVS morphosyntax, we found that at age 7, children have explicit as well as implicit knowledge of the passive morphosyntax. On the other hand, evidence that they have the knowledge of case-marking necessary to disambiguate OVS sentences is available on-line – as shown by the childrens reaction to the cues – but remains hidden in the off-line explicit task, probably due to the added difficulty posed by the sentences from an executive function perspective.

Position of the cue in the sentence

Finally, the analysis of the on-line data provide evidence of the role played by the temporal unfolding of the cues in the sentences. We could demonstrate that the task for the children and even for the adults is much more complicated when sentence revision must be performed late in the sentence, such as in temporarily ambiguous OVS sentences. In this condition, we saw that even adults were garden-pathed by the onset of the nominative case-marking during the second NP and were only marginally able to inhibit their reliance on the "agent-first strategy".

6.5.2 From a multilingual perspective

L1 and L2 children (studies 2 & 4)

In the two studies focusing on a multilingual perspective, we investigated and compared sentence comprehension between L1 and L2 children. The two groups differed primarily in the length of their exposure to the German language, which started at birth for the L1 children but not until age 3 or 4 for the L2 children. This type of bilingualism is named *early second language acquisition* in order to distinguish it from bilingualism, in which the L1 and L2 are acquired simultaneously from birth (Grimm & Schulz, 2016; Rothweiler, 2007; Unsworth, 2005). In this language acquisition type, the L2 is normally acquired with the child's entrance into an institutional environment such as kindergarten, whereas the L1 is the language spoken mostly within the family. L2 acquisition is not tutored like in a foreign language acquisition class as the child at age 3 or 4 is immersed in the new language environment without being explicitly instructed in it. Although corrections and/or explanations by the teaching staff or other children may occur in the kindergarten context, this is not comparable to a tutored language instruction experience. Another aspect distinguishing the two groups is the amount and quality of the input. L2 children receive less linguistic input altogether as it is mostly confined to the social/institutional setting, whereas L1 children are exposed full-time to the language in both the home and the social/institutional setting. Due to these differences, L2 children have been shown to be often less proficient than L1 children (e.g., Dimroth, 2007; Grießhaber, 2007; Grimm & Schulz, 2014). With regard to their cognitive maturity and in particular to the development of their two executive functions, namely working memory and inhibitory control, we assume no differences between the groups since they present the same age range and the research to date shows that the development of executive functions goes hand in hand with biological maturation.

Gradual on-line reliance on the most valid cues

Our analysis of the L1 and L2 children's on-line data during passive sentences revealed that both language groups reacted to the same disambiguating cues. We found a similar continuum to the one that emerged in the study comparing L1 adults

and children at age 7 and 10 (study 1). Crucially, however, we found that the L2 7-year-olds after 3-4 years of exposure relied more heavily on the "agent-first strategy" than the L1 age-matched children and also needed more time to react to the first passive cue as well as to exploit it to a similar degree. In addition, we showed that the use of this strategy diminished when the L2 children got older and were thus quantitatively more exposed to and more proficient with the L2. In a similar vein as between young and older monolinguals, once the L2 children had by age 10 longer exposure to the language and thus to the passive and OVS structures, they were better capable of exploiting valid cues and paying less attention to less valid cues. Since we assume that the L1 and L2 7-year-olds have the same executive functions, it seems plausible to argue that the L2 7-year-olds reacted later to the auxiliary *wurde* and exploited it less quickly than the L1 children more because of a relative deficit in their knowledge of the linguistic cues than because of a problem in inhibiting irrelevant cues. Interestingly, just as it is for monolinguals, the second language learners' reliance on the "agent-first strategy" is a less costly strategy that they adopt to start processing sentences. As we discussed in chapter 5, it is of interest that the first language of the second language learners is Turkish, a language with a rich inflectional morphology and in which the agent-action-patient ordering is violated more often than in German. In view of this, we might have expected this particular language group to adopt this strategy to a lower degree than the monolinguals. On the contrary, we found that second language learners have a stronger tendency to rely on it than monolinguals. Hence, we interpret the "agent-first strategy" overall as a processing behaviour that is not related to the L1 of the L2 children, Turkish, but rather is a more general property of less proficient language users. This choice might be dictated by the simplicity and ease of application of this strategy, making this explanation also suitable to explain the data of young, less proficient monolingual children.

The OVS data from study 4 corroborate this picture. Recall that differently to the study with passive sentences (study 2), in study 4 we tested only one age group, 7-year-olds, meaning that we do not have at our disposal a developmental picture of second language learners' use of case-marking and "agent-first strategy" in competition. What we were able to show, however, is that the L2 children's reliance

on case-marking in comparison to the L1 peers is very weak in the on-line data and not visible at all in their off-line performance. Importantly, we showed that the gap between off-line and on-line performance was strong for the L1 children and minimal for the L2 children. As a consequence, we suggest that L1 children performed poorly in particular because of deficits in their executive functions, that is, in maintaining the two interpretations at the same time until the end of the sentence and then choosing the correct one while inhibiting its competito. However, this argument does not seem to serve very well to explain the performance of the L2 children, whose linguistic knowledge of the structure in question does not appear to be fully developed and whose overall language proficiency is poorer than in the monolinguals.

Passive morphosyntax (study 2) vs. case-marking (study 4)

Similarly to what we saw in studies 1 and 3 involving monolingual children and adults, the L2 children revealed overall more difficulties with OVS than passive sentences. As we argued above, the on-line and off-line data of the L1 children suggest that OVS sentences are more demanding than passives from a cognitive perspective. Specifically, during OVS sentences (study 4), we found that first, L1 children waited until the second NP, the subject, in order to see whether the cue was compatible with a non-canonical interpretation of the sentence, and second, they were not able to maintain the correct interpretation until the end of the sentence. On the other hand, during passives (study 2), both L1 and L2 children were able to integrate the passive cue after its onset and performed very similarly off-line as on-line. Just as for our comparison of L1 and L2 children, we add another explanation for the greater difficulty apparently shown by the latter. If only executive function had played a role, then we would have expected a sharper gap between off-line and on-line performance like the one we found for the L1 children. On the contrary, we found that the difference was smaller and the L2 children's on-line exploitation was very minimal. Specifically, we argue that the fact that L2 children's reaction to case-marking was very weak in comparison to the L1 children might be explained by the category of case-marking itself. The acquisition of the German case-marking is a long and complex process because of the several syncretisms and the lack of transparency. In addition, each form of case-marking depends on the gender of the noun and gender is

in turn is difficult to acquire, as there is no clear relationship between the form of the noun and its gender in German.

Importantly, the children were tested on nominative and accusative case-marking prior to their taking part in this study with the *sentence imitation task.* Although at age 7, L2 children were shown to have mastered it marking it correctly, our experimental results show that this does not imply that in comprehension they necessarily regard it as a valid cue. In fact, the on-line data suggest that they rely on the "agent-first strategy" rather heavily and take the accusative marking in the first NP only very weakly into consideration.

Position of the cue in the sentence

As in the previous study focusing on a developmental perspective (study 3), the on-line data for the L1 and L2 children provide evidence of the role played by the position of the cues in the sentence. When the disambiguating cue occurred later, both groups revealed a very minimal reaction to it and were not capable of suppressing their initial commitment to the "agent-first strategy" in order to start relying on the new cue. However, just as we argued that L2 children had trouble understanding unambiguous OVS sentences because of insufficient linguistic knowledge, it may be that this hypothesis can also explain the results for the temporarily ambiguous sentences. As we suggested for monolinguals, it would be advisable for future studies to use stimulus sentences that are more natural and either contextualise them or mark them with prosodic cues.

L1 influence on processing in the L2

In this work, we tested only second language learners from a particular L1 context, namely Turkish. For this reason, we cannot make any statement concerning whether the L1 has an influence on the processing of children starting to acquire German around the age 3-4 because we do not have any other language group as comparison.

It is interesting, however, to recall that Turkish has a rich inflectional morphology and the thematic role ordering agent-before-patient ordering is more often violated than in German. Passive and OVS sentences can be found in Turkish as

well. The passive is marked with specific suffixes which are attached to the verb stem and the agent is either introduced by a preposition, or it presents an adverbial suffix or is case-marked. In OVS sentences, objects are mostly overt case-marked.

With this premise, we might have expected this particular language group to rely on the "agent-first strategy" to a lower degree than the monolingual German children. However, this was not the case, as we found that L2 children relied heavily on the "agent-first strategy" and made a stronger use of it than the L1 children.

In order to answer the question as to whether children starting to acquire the L2 at age 3-4 are, when processing in the L2, influenced by the processing strategies of their L1, it would be of interest to investigate the processing of more than one language group in future studies.

The importance of combining on-line and off-line methods

The results of the four studies point to the importance of checking participants' off-line judgements against on-line measurements such as the monitoring of participants' eye gaze movements in order to get the fullest possible picture of their linguistic processing and ascertain, for example, whether other factors such as executive function prevent them from making use of their on-line linguistic knowledge in the off-line task.

If we had based our analysis of passive and OVS sentences on off-line data alone, we would have not gained an insight into the strategies that participants make use of in order to obtain meaning. In our studies involving passives, for example, we would not have discovered that the groups differ in the paths they take to their successful interpretation of the sentences. Specifically, we would have not learned that despite high off-line performance younger L1 learners need more time than older children and adults to abandon the "agent-first strategy" and to rely on the passive auxiliary. The same holds for the second language learners: we would not have found out that in the first phases of L2 exposure, children rely stronger on the "agent-first strategy" and still have to learn to rely on the passive auxiliary, as they do later on at age 10, after longer exposure to the L2, similarly to the L1 age-matched children. In sum, the combination of on-line and off-line data for passives allowed us to learn that

the groups weight the cues to a different degree during processing despite the fact that at the end of the sentences their performance was very similar.

For the studies involving OVS sentences, we observed that, despite their poor performance with unambiguous OVS sentence, L1 and L2 children at age 7 actually recognized the function of *den* in the first NP and exploited it appropriately on-line. Though L1 children were shown to respond to the accusative cue much more than the L2 children, both groups were shown to have difficulty retaining the correct analysis until the end of the sentences. Again, this had a greater impact on the L1 children than on the L2 children, whose grasp of case-marking was less solid. In short, if we had not combined the two methods, we would have not learned that the complexity of OVS sentences and the consequent difficulty they present for processing involve more an overtaxing of participants' executive systems than their linguistic knowledge, at least for the L1 children. For the L2 children, we argued that their weaker knowledge of case-marking in competition with the "agent-first strategy" contributed heavily to their poor on-line and off-line performance. Furthermore, by investigating the on-line processing of temporarily ambiguous sentences, we were able to show that all participants, children as well as adults tried to revise their wrong initial commitment, and in particular that this behaviour was much more pronounced in the adults than in the child groups.

Last not least, we would have not learned that all groups, independently of age and language status, started out interpreting the sentences on the basis of the "agent-first strategy", and that the great challenge posed by non-canonical sentences is to stop relying on these cues when the conflicting cues intervene.

In general, we stress the importance for future studies on language acquisition of combining different methods.

Are passive and OVS sentences real stumbling blocks for young learners?

Our study confirms previous findings showing that OVS sentences are overall difficult for children to understand at age 7. As intended, we made the task even more difficult for our participants as the sentences were presented without context and prosodic information so that we could focus precisely on determining whether participants were able to make use of case-marking alone to understand the meaning

of the sentences. Surprisingly, the lack of a context and prosodic cues also strongly garden-pathed native-speaking adults, who are presumably expert listeners. On the other hand, we found that passive sentences did not seem to challenge any of the learners. In the literature on didactics, passive is regarded as a complex structure for both first and second language learners. Passive constructions occur frequently in school text books and are thought to be one of the elements that make reading comprehension more difficult for children. In part this is because in oral discourse speakers tend to use active constructions and simpler sentences preferentially, limiting children's overall exposure to the passive. The novel finding we provide that children actually seem to have little difficulty in comprehending passives off-line and on-line points, as already noted above, to the importance of using different methods simultaneously to investigate linguistic phenomena in order to avoid the risk of drawing too quickly erroneous conclusions about the origin of children's mistakes.

Implications for language teaching in a school context

The use of on-line methods such as eye-tracking is particularly useful for research in the field of language didactics as it enables us to explore which cues children process more successfully and which are instead more challenging. Once we know this, it is then possible to develop customised strategies and materials that will heighten children's awareness of the relevant cues and correct their linguistic deficits. This study shows that, although children can master the passive morphology, L2 children in particular will require more input in nominal morphology.

Moreover, studies on sentence processing enable us to ascertain which structures are processed with more ease than others. For example, in the present study, we showed that passives do not cause as much difficulty as OVS sentences do. Specifically, we were able to demonstrate that, despite showing knowledge of case-marking during unambiguous OVS sentences, L1 children were challenged by the structure from an executive perspective, as the gap between off-line and on-line performance was highly pronounced. We assume that even when L2 children master case-marking in conflict with the agent-before-patient ordering, presumably after longer exposure, they will probably, like their L1 peers, still find these sentences complex from a cognitive perspective. With this knowledge, experts in language

teaching have a basis on which to organise language input in such a way as to make it easily understood by learners and at the same time to progressively insert those structures that are considered more complex in order to foster their acquisition. Here again, the comparison of results from off-line and on-line methods could be used as a diagnostic tool to separate executive function issues from linguistic knowledge deficits.

More in general, by knowing which non-canonical sentences present the greatest amount of difficulty and why, as well as improving learner understanding by focusing on the formal aspects only, attention might also be paid in to raising children's awareness of the function of these sentences.

6.6 Conclusion

This dissertation is the first study on German to provide evidence from a processing perspective that acquisition consists in learning to fine-tune cues on-line in an adult- and native-like fashion, that is in learning step-by-step in the course of language development to rely on the most valid cues of the language. Just as in first language processing and acquisition, second language learners extract from the L2 input information concerning the language-specific cues' validity and learn to rely on them. During passives, after 3-4 years of exposure to the L2, the L2 children showed evidence of L2 parsing mechanisms that were similar to those seen in the age-matched L1 children. During OVS sentences, by contrast, processing between the groups was more differentiated, because we found that L2 children were particularly challenged by the use of case-marking competing with the processing preference of the canonical thematic role ordering, agent-before-patient. In this way, we confirmed the challenge posed by the case-marking system in L2 acquisition.

Furthermore, this investigation of the processing by different age and language groups of two structures, passive and OVS sentences, provides us with new and very interesting insights into the different mechanisms that play a role in the processing of non-canonical sentences. The fact that the gap between off-line and on-line performance during passives was overall less marked than that seen during OVS sentences allows us to conclude that non-canonical sentences are difficult for children to process for different reasons. Finally, we found that independently of age group and language status, the positon of the disambiguating cue in the sentence matters, since all groups found it difficult to integrate new cues later on in the sentence.

7 References

Abbot-Smith, K., & Behrens, H. (2006). How Known Constructions Influence the Acquisition of Other Constructions: The German Passive and Future Constructions. *Cognitive Science*, *30*(6), 995–1026.

Adani, F., & Fritzsche, T. (2015). On the relation between implicit and explicit measures of child language development: Evidence from relative clause processing in 4-year-olds and adults. In E. Grillo & K. Jepson (Eds.), *Proceedings of the 39th annual Boston University Conference on Language Development* (pp. 14–26). Somerville, MA: Cascadilla Press.

Ahrenholz, B. (2012). *Kinder mit Migrationshintergrund: Spracherwerb und Fördermöglichkeiten; Beiträge aus dem 1. Workshop "Kinder mit Migrationshintergrund", 2005. Beiträge aus dem Workshop "Kinder mit Migrationshintergrund"*. Stuttgart: Fillibach bei Klett.

Aschermann, E., Gülzow, I., & Wendt, D. (2004). Differences in the Comprehension of Passive Voice in German- and English-Speaking Children. *Swiss Journal of Psychology*, *63*(4), 235–245.

Baayen, R. H. (2008). *Analyzing linguistic data: A practical introduction to statistics using R*. Cambridge: Cambridge University Press.

Baddeley, A. D., & Hitch, G. J. (1994). Developments in the concept of working memory. *Neuropsychology*, *8*(4), 485–493.

Bader, M., & Meng, M. (2000). Subject-object ambiguities in German embedded clauses: an across-the-board comparison. *Journal of Psycholinguistic Research*, *28*(2), 121–143.

Bahlmann, J., Rodriguez-Fornells, A., & Rotte, M. (2007). An fMRI Study of Canonical and Noncanonical Word Order in German. *Human Brain Mapping*, *28*(10), 940–949.

Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language*, *68*(3), 255–278.

Bast, C. (2003). *Der Altersfaktor im Zweitspracherwerb - die Entwicklung der grammatischen Kategorien Numerus, Genus und Kasus in der Nominalphrase im*

ungesteuerten Zweitspracherwerb des Deutschen bei russischen Lernerinnen. Phd Thesis, Universität zu Köln.

Baten, K. (2013). *The acquisition of the German case system by foreign language learners*. *Processability Approaches to Language Acquisition Research & Teaching* (Vol. 2). Amsterdam, Philadelphia: John Benjamins Publishing Company.

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software*, *67*(1), 1–48.

Bates, E., & MacWhinney, B. (1987). Competition, variation, and language learning. In B. MacWhinney (Ed.), *Mechanisms of Language Acquisition* (pp. 157–193). Hillsdale, NJ: Lawrence Erlbaum.

Bates, E., & MacWhinney, B. (1989). Functionalisms and the Competition Model. In B. MacWhinney & E. Bates (Eds.), *The Crosslinguistic Study of Sentence Processing* (pp. 3–76). Cambridge: Cambridge University Press.

Bates, E., MacWhinney, B., Caselli, C., Devescovi, A., Natale, F., & Venza, V. (1984). A Cross-Linguistic Study of the Development of Sentence Interpretation Strategies. *Child Development*, *55*(2), 341–354.

Baur, R., & Spettman, M. (2009). Der C-Test als Instrument der Sprachdiagnose und Sprachförderung. In D. Lengyel (Ed.), *Von der Sprachdiagnose zur Sprachförderung*. Vol. 5 (pp. 115–127). Münster, New York, München, Berlin: Waxmann.

Becker, T. (2006). Erwerb und Verarbeitung komplexer grammatischer Strukturen bei Grundschulkindern. In T. Becker & C. Peschel (Eds.), *Gesteuerter und ungesteuerter Grammatikerwer. Diskussionsforum Deutsch: Bd. 20* (pp. 156–173). Baltmannsweiler: Schneider Verlag Hohengehren.

Bever, T. G. (1970). The cognitive basis for linguistic structures. In J. Hayes (Ed.), *Cognition and the development of language* (pp. 279–362). New York: Wiley.

Bialystok, E., & Craik, F. I. M. (2010). Cognitive and linguistic processing in the bilingual mind. *Current Directions in Psychological Science*, *19*(1), 19–23.

Bialystok, E., Craik, F. I. M., Klein, R., & Viswanathan, M. (2004). Bilingualism, Aging, and Cognitive Control: Evidence From the Simon Task. *Psychology and Aging*, *19*(2), 290–303.

Binanzer, A. (2017). Genuskongruenz im Zweitspracherwerb. Eine Untersuchung zum Erwerb des deutschen Genussystems durch Grundschulkinder mit türkischer und russischer Erstsprache. Berlin, New York: Mouton de Gruyter.

Biran, M., & Ruigendijk, E. (2015). Do case and gender information assist sentence comprehension and repetition for German- and Hebrew-speaking children? *Lingua*, *164*, 215–238.

Brandt-Kobele, O. C., & Höhle, B. (2010). What asymmetries within comprehension reveal about asymmetries between comprehension and production: The case of verb inflection in language acquisition. *Lingua*, *120*(8), 1910–1925.

Brinker, K. (1971). *Das Passiv im heutigen Deutsch. Form und Funktion. Heutiges Deutsch* (Reihe 1: Vol. 2). München, Düsseldorf: Max Hueber.

Brown, R. (1973). *A first language*. Cambridge: Harvard University Press.

Candan, A., Küntay, A. C., Yeh, Y. C., Cheung, H., Wagner, L., & Naigles, L. R. (2012). Language and age effects in children's processing of word order. *Cognitive Development*, *27*(3), 205–221.

Cerella, J., & Hale, S. (1994). The rise and fall in information-processing rates over the life span. *Acta Psychologica*, *86*(2-3), 109–197.

Chan, A., Lieven, E., & Tomasello, M. (2009). Children's understanding of the agent-patient relations in the transitive construction: Cross-linguistic comparisons between Cantonese, German, and English. *Cognitive Linguistics*, *20*(2), 267–300.

Choi, Y., & Trueswell, J. C. (2010). Children's (in)ability to recover from garden paths in a verb-final language: Evidence for developing control in sentence processing. *Journal of Experimental Child Psychology*, *106*(1), 41–61.

Chomsky, N. (1981). *Lectures on government and binding: The Pisa lectures*. *Studies in generative grammar*. Berlin, New York: Mouton de Gruyter.

Chondrogianni, V., & Marinis, T. (2012). Production and processing asymmetries in the acquisition of tense morphology by sequential bilingual children. *Bilingualism: Language and Cognition*, *15*(1), 5–21.

Clahsen, H. (1984). Der Erwerb von Kasusmarkierungen in der deutschen Kindersprache. *Linguistische Berichte*, *89*, 1–31.

Clahsen, H., & Felser, C. (2006). Grammatical processing in language learners. *Applied Psycholinguistics*, *27*(1), 3–42.

Costa, A., Hernandez, M., Costa-Faidella, J., & Sebastian-Galles, N. (2009). On the bilingual advantage in conflict processing: now you see it, now you don't. *Cognition*, *113*(2), 135–149.

Dąbrowska, E., & Street, J. (2006). Individual differences in language attainment: Comprehension of passive sentences by native and non-native English speakers. *Language Sciences*, *28*(6), 604–615.

Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading. *Journal of Verbal Learning and Verbal Behavior*, *19*(4), 450–466.

Davidson, M. C., Amso, D., Anderson, L. C., & Diamond, A. (2006). Development of cognitive control and executive functions from 4 to 13 years: Evidence from manipulations of memory, inhibition, and task switching. *Neuropsychologia*, *44*(11), 2037–2078.

De Vincenzi, M. (1991). *Syntactic Parsing Strategies in Italian: The Minimal Chain Principle*. *Studies in Theoretical Psycholinguistics*. (Vol. 12). Dordrecht: Springer Netherlands.

Demiral, Ş. B., Schlesewsky, M., & Bornkessel-Schlesewsky, I. (2008). On the universality of language comprehension strategies: Evidence from Turkish. *Cognition*, *106*(1), 484–500.

Diamond, A. (2013). Executive functions. *Annual review of psychology*, *64*, 135–168.

Diehl, E., Christen, H., & Leuenberger, S. (2000). *Grammatikunterricht, alles für der Katz?: Untersuchungen zum Zweitsprachenerwerb Deutsch*. *Reihe Germanistische Linguistik.* (Vol. 220). Tübingen: Max Niemeyer Verlag.

Dimroth, C. (2007). Zweitspracherwerb bei Kindern und Jugendlichen. Gemeinsamkeiten und Unterschiede. In T. Anstatt (Ed.), *Mehrsprachigkeit bei Kindern und Erwachsenen* (pp. 115–137). Tübingen: Narr Francke Attempto.

Dimroth, C., & Haberzettl, S. (2008). Je älter desto besser. Lernen Kinder Deutsch als Zweitsprache schneller als Deutsch als Erstsprache?. In B. Ahrenholz, U. Bredel, W. Klein, M. Rost-Roth & R. Skiba (Eds.), *Empirische Forschung und Theoriebildung. Beiträge aus der Soziolinguistik, Gesprochene-Sprache-Forschung und Zweitspracherwerbsforschung (pp.* 227-239). Berlin: Lang.

Dittmar, M., Abbot-Smith, K., Lieven, E., & Tomasello, M. (2008). German Childrens Comprehension of Word Order and Case Marking in Causative Sentences. *Child Development*, *79*(4), 1152–1167.

Dittmar, M., Abbot-Smith, K., Lieven, E., & Tomasello, M. (2014). Familiar Verbs Are Not Always Easier Than Novel Verbs: How German Pre-School Children Comprehend Active and Passive Sentences. *Cognitive Science*, *38*(1), 128–151.

Dryer, M. S. (1995). Frequency and pragmatically unmarked word order. In P. A. Downing & M. Noonan (Eds.), *Word Order in Discourse.* (Vol. 30, pp. 105–135). Amsterdam: John Benjamins Publishing Company.

Duden (2009). *Die Grammatik. Unentbehrlich für richtiges Deutsch*. Band IV, 8., überarbeitet Auflage. Mannheim, Zürich: Dudenverlag.

Ehlich, K., Bredel, U., & Reich, H. H. (2008). *Referenzrahmen zur altersspezifischen Sprachaneignung – Forschungsgrundlagen*. Bonn, Berlin: Bundesministerium für Bildung und Forschung (BMBF).

Eisenberg, P. (2013). *Grundriss der deutschen Grammatik. Band 2: Der Satz*. (4. aktualisierte und überarbeite Auflage). Stuttgart: Metzler.

Ellis, N. C. (2008). Implicit and explicit knowledge about language. In N. Hornberger (Ed.), *Encyclopedia of Language and Education, Second Edition, Volume 6: Knowledge about Language* (pp. 119–132). Springer US.

Erguvanli, E. E. (1984). *The function of word order in Turkish grammar*. Berkeley, London: University of California Press.

Erlam, R. (2006). Elicited Imitation as a Measure of L2 Implicit Knowledge: An Empirical Validation Study. *Applied Linguistics*, *27*(3), 464–491.

Felser, C., & Roberts, L. (2007). Processing wh-dependencies in a second language: A cross-modal priming study. *Second Language Research*, *23*(1), 9–36.

Felser, C., Marinis, T., & Clahsen, H. (2003). Children's Processing of Ambiguous Sentences: A Study of Relative Clause Attachment. *Language Acquisition*, *11*(3), 127–163.

Ferreira, F. (2003). The misinterpretation of noncanonical sentences. *Cognitive Psychology*, *47*(2), 164–203.

Ferreira, F., & Henderson, J. M. (1991). Recovery from misanalyses of garden-path sentences. *Journal of Memory and Language*, *30*, 725–745.

Fiebach, C. J., Schlesewsky, M., & Friederici, A. D. (2001). Syntactic working memory and the establishment of filler-gap dependencies: insights from ERPs and fMRI. *Journal of Psycholinguistic Research*, *30*(3), 321–338.

Frazier, L., & Clifton, C. J. (1989). Successive cyclicity in the grammar and the parser. *Language and Cognitive Processes*, *4(2)*, 93–126.

Frazier, L., & Flores D´Arcais, G. B. (1989). Filler-driven parsing: A study of gap filling in Dutch. *Journal of Memory and Language*, *28*(3), 331–344.

Frazier, L., & Fodor, J. (1978). The sausage machine: A new two-stage parsing model. *Cognition*, *6*, 291–326.

Friederici, A. D. (2015). Neurocognition of Language Development. In E. L. Bavin & L. R. Naigles (Eds.), *The Cambridge Handbook of Child Language* (pp. 61–88). Cambridge, New York: Cambridge University Press.

Friederici, A. D., Steinhauer, K., & Mecklinger, A. (1998). Working memory constraints on syntactic ambiguity resolution as revealed by electrical brain responses. *Biological Psychology*, *47*, 193–221.

Friedmann, N., & Novogrodsky, R. (2004). The acquisition of relative clause comprehension in Hebrew: A study of SLI and normal development. *Journal of Child Language*, *31*(3), 661–681.

Fritzenschaft, A. (1994). Activating Passives in Child Grammar. In R. Tracy & E. Lattey (Eds.), *Linguistische Arbeiten: Vol. 309. How tolerant is universal grammar? Essays on language learnability and language variation* (pp. 155–184). Tübingen: Max Niemeyer Verlag.

Gamper, J. (2016). *Satzinterpretationsstrategien mehr- und einsprachiger Kinder im Deutschen*. Tübingen: Narr Francke Attempto.

Gathercole, S. E., Pickering, S. J., Ambridge, B., & Wearing, H. (2004). The Structure of Working Memory From 4 to 15 Years of Age. *Developmental Psychology*, *40*(2), 177–190.

Gibson, E. (1998). Linguistic complexity: locality of syntactic dependencies. *Cognition*, *68*, 1–76.

Givon, T. (1995). *Functionalism and grammar*. Amsterdam: John Benjamins Publishing Company.

Gorrell, P. (2000). The subject-before-object preference in German. In B. Hemforth & L. Konieczny (Eds.), *Studies in Theoretical Psycholinguistics. German sentence processing*. Dordrecht, London: Kluwer Academic Publishers.

Grewe, T., Bornkessel-Schlewesky, I., Zysset, S., Wiese, R., Cramon, D. Y. von, & Schlewesky, M. (2007). The role of the posterior superior temporal sulcus in the processing of unmarked transitivity. *NeuroImage* (35), 343–352.

Grießhaber, W. (2006). Die Entwicklung der Grammatik in Texten vom 1. bis zum 4. Schuljahr. In B. Ahrenholz (Ed.), *Kinder mit Migrationshintergrund. Spracherwerb und Fördermöglichkeiten* (pp. 150–167). Freiburg im Breisgau: Fillibach bei Klett.

Grießhaber, W. (2007). Zweitspracherwerbsprozesse als Grundlage der Zweitsprachförderung. In B. Ahrenholz (Ed.), *Deutsch als Zweitsprache : Voraussetzungen und Konzepte für die Förderung von Kindern und Jugendlichen mit Migrationshintergrund* (pp. 31–48). Freiburg im Breisgau: Fillibach bei Klett.

Grimm, A., & Schulz, P. (2014). Sprachfähigkeiten von Kindern mit DaZ bei Schuleintritt. In B. Lütke & I. Petersen (Eds.), *Deutsch als Zweitsprache: erwerben, lernen und lehren. Beiträge zum 9. Workshop Kinder mit Migrationshintergrund* (pp. 35–50). Stuttgart: Fillibach bei Klett.

Grimm, A., & Schulz, P. (2016). Warum man bei mehrsprachigen Kindern dreimal nach dem Alter fragen sollte: Sprachfähigkeiten simultan-bilingualer Lerner im Vergleich mit monolingualen und frühen Zweitsprachlernern. *Diskurs Kindheits- und Jugendforschung 1,* 27–42.

Grimm, H. (1975). Verstehen, Imitation und Produktion von Passivsätzen. In H. Grimm, H. Scholer, & M. Wintermantel (Eds.), *Beltz Monographien. Zur Entwicklung Sprachlicher strukturformen bei Kindern* (pp. 73–99). Weinheim: J. Beltz Verlag.

Haberzettl, S. (1998). FHG in der Lernersprache, oder: Gibt es ein diskursfunktionales Strukturierungsprinzip im L2-Syntaxerwerb? In H. Wegener (Ed.), *Eine zweite Sprache lernen: empirische Untersuchungen zum Zweitspracherwerb* (pp. 117–141). Tübingen: Narr Francke Attempto.

Hale, J. (2001). A Probabilistic Earley Parser as a Psycholinguistic Model. In: *Proceedings of the Second Meeting of the North American Chapter of the*

Asssociation for Computational Linguistics (pp.159-166). Pittsburgh, Pennsylvania: Association for Computational Linguistics.

Hemforth, B., Konieczny, L., & Strube, G. (1993). *Incremental syntax processing and parsing strategies*. Hillsdale, NJ: Lawrence Erlbaum.

Hilchey, M. D., & Klein, R. M. (2011). Are there bilingual advantages on nonlinguistic interference tasks? Implications for the plasticity of executive control processes. *Psychonomic Bulletin & Review*, *18*(4), 625–658.

Hopp, H. (2006). Syntactic features and reanalysis in near-native processing. *Second Language Research*, *22*(3), 369–397.

Hopp, H. (2010). Ultimate attainment in L2 inflection: Performance similarities between non-native and native speakers. *Lingua*, *120*(4), 901–931.

Huang, Y. T., Zheng, X., Meng, X., & Snedeker, J. (2013). Children's assignment of grammatical roles in the online processing of Mandarin passive sentences. *Journal of Memory and Language*, *69*(4), 589–606.

Huang, Y., Gerard, J., Hsu, N., Kowalski, A, & Novick, J. (2016). *Cognitive-control effects on the kindergarten path: Separating correlation from causation.* Poster presented at the 29th Annual CUNY Conference on Human Sentence Processing. Gainesville, Florida.

Jackson, C. N., & Roberts, L. (2010). Animacy affects the processing of subject–object ambiguities in the second language: Evidence from self-paced reading with German second language learners of Dutch. *Applied Psycholinguistics*, *31*(4), 671–691.

Jaeger, T. F. (2008). Categorical data analysis: Away from ANOVAs (transformation or not) and towards logit mixed models. *Journal of Memory and Language*, *59*(4), 434–446.

Järvikivi, J., Pyykkönen-Klauck, P., Schimke, S., Colonna, S., & Hemforth, B. (2013). Information structure cues for 4-year-olds and adults: Tracking eye movements to visually presented anaphoric referents. *Language, Cognition and Neuroscience*, *29*(7), 877–892.

Jeuk, S. (2006). Zweitspracherwerb im Anfangsunterricht – Erste Ergebnisse. In B. Ahrenholz (Ed.), *Kinder mit Migrationshintergrund. Spracherwerb und Fördermöglichkeiten* (pp. 186–202). Freiburg im Breisgau: Fillibach bei Klett.

Jeuk, S. (2013). Aspekte der Nominalfexion bei mehrsprachigen Kindern. In I. Oomen-Welke (Ed.), *Mehrsprachigkeit in der Klasse wahrnehmen - aufgreifen - fördern* (pp. 99–110). Stuttgart: Fillibach bei Klett.

Jiang, N. (2004). Morphological insensitivity in second language processing. *Applied Psycholinguistics*, *25*(4), 603–634.

Kail, R. (1991). Developmental change in speed of processing during childhood and adolescence. *Psychological Bulletin*, *109*(3), 490–501.

Kaltenbacher, E., & Klages, H. (2006). Sprachprofil und Sprachförderung bei Vorschulkindern mit Migrationshintergrund. In B. Ahrenholz (Ed.), *Kinder mit Migrationshintergrund Spracherwerb und Fördermöglichkeiten* (pp. 80–97). Freiburg im Breisgau: Fillibach bei Klett.

Kamide, Y., Scheepers, C., & Altmann, G. T. M. (2003). Integration of Syntactic and Semantic Information in Predictive Processing: Cross-Linguistic Evidence from German and English. *Journal of Psycholinguistic Research*, *32*(1), 37–55.

Kempe, V., & MacWhinney, B. (1999). Processing of morphological and semantic cues in Russian and German. *Language and Cognitive Processes*, *14*, 129–171.

Kilborn, K. (1989). Sentence Processing in Japanese-English and Dutch-English bilinguals. In B. MacWhinney & E. Bates (Eds.), *The Crosslinguistic Study of Sentence Processing* (pp. 257–291). Cambridge: Cambridge University Press.

Klages, H., & Gerwien, J. (2015). Verstehen anaphorischer Personalpronomina im DaZ- und DaM-Erwerb. In H. Klages & G. Pagonis (Eds.), *DaZ-Forschung: Band 7. Linguistisch fundierte Sprachförderung und Sprachdidaktik. Grundlagen, Konzepte, Desiderate* (pp. 71–98). New York, Berlin: De Gruyter.

Knoeferle, P., Crocker, M. W., Scheepers, C., & Pickering, M. J. (2005). The influence of the immediate visual context on incremental thematic role-assignment: Evidence from eye-movements in depicted events. *Cognition*, *95*(1), 95–127.

Konieczny, L. (1996). Human sentence processing: A semantics-oriented approach. Phd Thesis, University of Freiburg.

Köpcke, K. M. (2003). Grammatische Komplexität und die Beherrschung der Kasusmorphologie durch Grundschulkinder. *Didaktik Deutsch*, *14*, 55–68.

Lehto, J. E., Juujärvi, P., Kooistra, L., & Pulkkinen, L. (2003). Dimensions of executive functioning: Evidence from children. *British Journal of Developmental Psychology*, *21*(1), 59–80.

Lenroot, R. K., & Giedd, J. N. (2006). Brain development in children and adolescents: Insights from anatomical magnetic resonance imaging. *Neuroscience & Biobehavioral Reviews*, *30*(6), 718–729.

Lindner, K. (2003). The development of sentence-interpretation strategies in monolingual German-lernaing children with and without specific language impairment. *Linguistics*, *41*(2), 213–254.

Luna, B., Garver, K. E., Urban, T. A., Lazar, N. A., & Sweeney, J. A. (2004). Maturation of cognitive processes from late childhood to adulthood. *Child Development*, *75*(5), 1357–1372.

MacWhinney, B. (2005). A Unified Model of Language Acquisition. In A. M. De Groot & J. Kroll (Eds.), *Handbook of Bilingualism* (pp. 49–67). Oxford: Oxford University Press.

Maratsos, M. P. (1974). Children who get worse at understanding the passive: a replication of Bever. *Journal of Psycholinguistic Research*, (3), 65–74.

Marinis, T. (2007). On-line Processing of Passives in L1 and L2 Children. In A. Belikova, L. Meroni, & M. Umeda (Eds.), *Proceedings of the 2nd Conference on Generative Approaches to Language Acquisition North America (GALANA)* (pp. 265–276). Somerville, MA: Cascadilla Proceedings Project.

Marinis, T. (2008). On-line Processing of Sentences Involving Reflexive and Non-reflexivePronouns in L1 and L2 Children. In A. Gavarró & M. J. Freitas (Eds.), *Language acquisition and development. Proceedings of GALA 2007* (pp. 348–358). Newcastle: Cambridge Scholars.

Marinis, T. (2010). Using on-line processing methods in language acquisition research. In W. B. T. Blom & S. Unsworth (Eds.), *Language learning & language teaching: Vol. 27. Experimental methods in language acquisition research* (pp. 139–162). Philadelphia: John Benjamins Publishing Company.

Marinis, T., & Saddy, D. (2013). Parsing the Passive: Comparing Children With Specific Language Impairment to Sequential Bilingual Children. *Language Acquisition*, *20*(2), 155–179.

Marouani, Z. (2006). *Der Erwerb des Deutschen durch arabischsprachige Kinder - Eine Studie zur Nominalflexion*. Phd Thesis, Universität Heidelberg.

Matin, E., Shao, K. C., & Boff, K. R. (1993). Saccadic overhead: Information-processing time with and without saccades. *Perception & Psychophysics*, *53*(4), 372–380.

Mazuka, R., Jincho, N., & Oishi, H. (2009). Development of Executive Control and Language Processing. *Language and Linguistics Compass*, *3*(1), 59–89.

McDade, H., Simpson, M., & Lamb, D. (1982). The use of elicited imitation as a measure of expressive grammar: A question of validity. *Journal of Speech and Hearing Disorders*, *47*, 19–24.

McFadden, T. (2003). On Morphological Case and Word-Order Freedom. *Annual Meeting of the Berkeley Linguistics Society*, *29*(1), 295–306.

Meisel, J. M. (1986). Word order and case marking in early child language. Evidence from simultaneous acquisition of two first languages. French and German. Linguistics, *24*, 123–183.

Meisel, J. M. (2009). Second Language Acquisition in Early Childhood. *Zeitschrift für Sprachwissenschaft*, *28*(1), 5–34.

Miao, X. C., Chen, G. P., & Yin H. C. (1984). Reexamination of the roles of word order and lexical learning in Chinese sentence comprehension Sciences. *Information on Psychological Sciences*, *6*, 1–7.

Mills, A. E. (1977). *Parallel Studies in first and second language acquisition*. Ludwigsburg: R. O. U. Strauch Ludwigsburg.

Mills, A. E. (1985). The Acquisition Of German. In D. I. Slobin (Ed.), *The crosslinguistic study of language acquisition* (pp. 141–254). Hillsdale, NJ: Lawrence Erlbaum.

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The Unity and Diversity of Executive Functions and Their Contributions to Complex "Frontal Lobe" Tasks: A Latent Variable Analysis. *Cognitive Psychology*, *41*(1), 49–100.

Musan, R. (2010). *Informationsstruktur. Kurze Einführungen in die germanistische Linguistik*. Heidelberg: Universitätsverlag Winter GmbH.

Novick, J. M., Hussey, E., Teubner-Rhodes, S., Harbison, J. I., & Bunting, M. F. (2013). Clearing the garden-path: Improving sentence processing through cognitive control training. *Language, Cognition and Neuroscience*, *29*(2), 186–217.

Parasuraman, R. (Ed.). (1998). *The attentive brain*. Cambridge, Massachussets, London: MIT Press.

Pierce, A. E. (2009). The Acquisition of Passives in Spanish and the Question of A-Chain Maturation. *Language Acquisition*, *2*(1), 55–81.

Poarch, G. J., & van Hell, J. G. (2012). Executive functions and inhibitory control in multilingual children: evidence from second-language learners, bilinguals, and trilinguals. *Journal of Experimental Child Psychology*, *113*(4), 535–551.

Pyykkönen, P., Matthews, D., & Järvikivi, J. (2010). Three-year-olds are sensitive to semantic prominence during online language comprehension: A visual world study of pronoun resolution. *Language and Cognitive Processes*, *25*(1), 115–129.

Rayner, K. (1998). Eye movements in reading and information processing: 20 years of research. *Psychological Bulletin*, *124*(3), 372–422.

Reyes, I., & Hernández, A. E. (2006). Sentence interpretation strategies in emergent bilingual children and adults. *Bilingualism*, *9*(1), 51–69.

Rickheit, G. (1975). *Zur Entwicklung der Syntax im Grundschulalter*. Düsseldorf: Pädagogischer Verlag Schwann.

Roesch, A. D., & Chondrogianni, V. (2014). Morphological cues in the comprehension of wh-questions in German-speaking simultaneous and early sequential bilingual children. In W. Orman & M. J. Valleau (Eds.), *Proceedings of the 38th annual Boston University Conference on Language Development* (pp. 380–392). Somerville, MA: Cascadilla Press.

Root, M. (2014). Lesen als Herausforderung für Zweitsprachlerner. Eine Empirische Untersuchung zum Passivverstehen von Viertklässlern. In C. Dawidowski (Ed.), *Schwerpunktheft der IMIS-Studien. Literatur, Lesen und Migration* (pp. 139–150). Osnabrück: Universität Osnabrück Institut für Migrationsforschung und Interkulturelle. Studien.

Rösch, H. (2011). *Deutsch als Zweit- und Fremdsprache*. *Akademie Studienbücher - Sprachwissenschaft*. Berlin: Akademie Verlag.

Rösler, F., Pechmann, T., Streb, J., Röder, B., & Hennighausen, E. (1998). Parsing of Sentences in a Language with Varying Word Order: Word-by-Word Variations of Processing Demands Are Revealed by Event-Related Brain Potentials. *Journal of Memory and Language*, *38*(2), 150–176.

Rothweiler, M. (2007). Bilingualer Spracherwerb und Zweitspracherwerb. In M. Steinbach (Ed.), *Schnittstellen der germanistischen Linguistik* (pp. 103–135). Stuttgart: Metzler.

Sachs, J. (1967). Recognition memory for syntactic and semantic aspects of connected discourse. *Perception and Psychophysics*, *2*, 437–442.

Schaner-Wolles, C. (1989). Strategies in acquiring grammatical relations in German: Word order or case marking? *Folia Linguistica*, *23*(1), 131–156.

Schimke, S. (2009). *The acquisition of finiteness by Turkish learners of German and Turkish learners of French: Investigating knowledge of forms and functions in production and comprehension.* Nijmegen: MPI Series in Psycholinguistics.

Schimke, S. (2011). Variable verb placement in second-language German and French: Evidence from production and elicited imitation of finite and nonfinite negated sentences. *Applied Psycholinguistics*, *32*(4), 635–685.

Schimke, S. (2015). Die rezeptive Verarbeitung von Markierungen der Diskurskohärenz bei Grundschulkindern mit Deutsch als Erst- oder Zweitsprache. In H. Klages & G. Pagonis (Eds.), *DaZ-Forschung: Band 7. Linguistisch fundierte Sprachförderung und Sprachdidaktik. Grundlagen, Konzepte, Desiderate* (pp. 193–214). New York, Berlin: De Gruyter.

Schipke, C. S., Knoll, L. J., Friederici, A. D., & Oberecker, R. (2012). Preschool children's interpretation of object-initial sentences: neural correlates of their behavioral performance. *Developmental Science*, *15*(6), 762–774.

Schlesewsky, M., Fanselow, G., Kliegl, R., & Krems, J. (2000). The subject preference in the processing of locally ambiguous Wh-questions in German. In B. Hemforth & L. Konieczny (Eds.), *Studies in Theoretical Psycholinguistics. German sentence processing*. Dordrecht, London: Kluwer Academic Publishers.

Schneitz, S. (2015). Passiv im kindlichen Zweitspracherwerb – Diagnostik und Förderimplikationen. In H. Klages & G. Pagonis (Eds.), *DaZ-Forschung: Band 7.*

Linguistisch fundierte Sprachförderung und Sprachdidaktik. Grundlagen, Konzepte, Desiderate. New York, Berlin: De Gruyter.

Sekerina, I., Karin, S., & Arild, H. (2004). How do children and adults process referentially ambiguous pronouns? *Journal of Child Language*, *31*, 123–152.

Simon, J. R., & Rudell, A. P. (1967). Auditory S-R compatibility: The effect of an irrelevant cue on information processing. *Journal of Applied Psychology*, *51*(3), 300–304.

Slobin, D. (1982). Universal and particular in the acquisition of language. In E. Wanner & L. R. Gleitman (Eds.), *Language acquisition. The state of the art* (pp. 128–170). Cambridge: Cambridge University Press.

Slobin, D. I., & Bever, T. G. (1982). Children use canonical sentence schemas: A crosslinguistic study of word order and inflections. *Cognition*, *12*, 229–265.

Snedeker, J., & Trueswell, J. C. (2004). The developing constraints on parsing decisions: The role of lexical-biases and referential scenes in child and adult sentence processing. *Cognitive Psychology*, *49*(3), 238–299.

Statistisches Bundesamt Deutschland (2016). Retrieved from https://www.destatis.de/DE/Publikationen/Thematisch/Bevoelkerung/MigrationIntegration/AuslaendBevoelkerung2010200167004.pdf?__blob=publicationFile

Stephany, U., & Voeĭkova, M. D. (2009). *Development of nominal inflection in first language acquisition: A cross-linguistic perspective*. *Studies on language acquisition: Vol. 30*. Berlin, New York: De Gruyter.

Stromswold, K. (under review). *Why Children Understand and Misunderstand Sentences: An Eye-tracking Study of Passive Sentences*.

Stromswold, K., Eisenband, Norland, & Ratzan. (2002). *Tracking the acquisition and processing of English passives: Using acoustic cues to disam-biguate actives and passives*. Paper presented at the CUNY Conference on Sentence Processing. New York.

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, *18*(6), 643–662.

Szagun, G. (2013). *Sprachentwicklung beim Kind: Ein Lehrbuch* (5th ed.). Weinheim: Beltz.

Tanenhaus, M. K., Spivey-Knowlton, M. J., Eberhard, K. M., & Sedivy, J. C. (1995). Integration of visual and linguistic information during spoken language comprehension. *Science, 268*, 1632–1634.

Tracy, R. (1986). The acquisition of case morphology in German. *Linguistics*, *24*(1), 47–78.

Trueswell, J. C., & Gleitman, L. R. (2007). Learning to parse and its implications for language acquisition. In M. G. Gaskell & G. T. M. Altmann (Eds.), *The Oxford handbook of psycholinguistics*. Oxford, New York: Oxford University Press.

Trueswell, J. C., Sekerina, I., Hill, N. M., & Logrip, M. L. (1999). The kindergarten-path effect: Studying on-line sentence processing in young children. *Cognition*, *73*(2), 89–134.

Trueswell, J. C., & Tanenhaus, M. K. (1994). Toward a lexicalist framework for constraint-based syntactic ambiguity resolution. In C. Clifton, Frazier, Lyn. Ed, & K. Rayner (Eds.), *Perspectives on sentence processing. 6th Sentence processing conference* (pp. 155–179). Hillsdale, NJ: Lawrence Erlbaum.

Turner, E. A., & Rommetveit, R. (1967). The acquisition of sentence voice and reversibility. *Child Development*, 38, 649–660.

Ullman, M. T. (2004). Contributions of memory circuits to language: the declarative/procedural model. *Cognition*, *92*(1-2), 231–270.

Unsworth, S. (2005). *Child L2, Adult L2, Child L1: Differences and Similarities. A study on the acquisition of direct object scrambling in Dutch*. PhD thesis, Utrecht University.

Weber, A., Grice, M., & Crocker, M. (2006). The role of prosody in the interpretation of structural ambiguities: A study of anticipatory eye movements. *Cognition*, *99*(2), 63–72.

Wegener, H. (1995). *Die Nominalflexion des Deutschen: Verstanden als Lerngegenstand. Reihe Germanistische Linguistik* (Vol. 151). Tübingen: Max Niemeyer Verlag.

Wegener, H. (1998). Das Passiv im DaZ-Erwerb von Grundschulkindern. In H. Wegener (Ed.), *Eine zweite Sprache lernen: empirische Untersuchungen zum Zweitspracherwerb* (pp. 143–172). Tübingen: Narr Francke Attempto.

Weighall, A. R. (2007). The kindergarten-path effect revisited : children's use of context in processing structural ambiguities. *Journal of Experimental Child Psychology*, *99*(2), 75–95.

Wendt, D., Brand, T., & Kollmeier, B. (2014). An Eye-Tracking Paradigm for Analyzing the ProcessingTime of Sentences with Different Linguistic Complexities. *PLoS ONE*, *9*(6), 1–13.

Williams, J. N. (2006). Incremental interpretation in second language sentence processing. *Bilingualism*, *9*(1), 71–88.

Wittek, A., & Tomasello, M. (2005). German-speaking children's productivity with syntactic constructions and case morphology: Local cues act locally. *First Language*, *25*(1), 103–125.

Zifonun, G., Hoffmann, L., Strecker, B., & Ballweg, J. (1997). *Grammatik der deutschen Sprache. Schriften des Instituts für Deutsche Sprache: Band 7*. Berlin, New York: De Gruyter.

8 Appendix

Appendix A: Participants in the experiment

A.1 Information about the L1 7-year-olds and 10-year-olds[48] from the study on passive sentences

7-year-olds

Subject -No.	Gender	Age (years; months)
1	F	6;9
2	F	6;7
3	F	---
4	F	7;6
5	F	7;1
6	M	7;5
7	F	7
8	M	6;8
9	F	7;1
10	M	7;8
11	F	8
12	F	7;1
13	F	7;4
14	F	6;6
15	F	7;2
16	M	6;8
17	M	6;11
18	F	7;6
19	F	7;6
20	M	7;6
21	F	6;7
22	F	6;7
23	M	6;8
24	F	7;8

10-year-olds

Subject -No.	Gender	Age (years)
1	M	10
2	M	10
3	M	9
4	M	10
5	M	10
6	F	10
7	F	10
8	M	9
9	F	11
10	F	10
11	F	10
12	M	10
13	F	10
14	F	10
15	F	10
16	M	10
17	F	10
18	F	9
19	F	10
20	M	10
21	M	10
22	M	10
23	F	11
24	F	11
25	M	9

[48] For the L1 10-year-olds, we did not collect information on their birthday and thus only have their age expressed in years. "- - - " means that information is not available.

A.2 Information about the L2 7-year-olds and 10-year-olds[49] from the study on passive sentences [50]

7-year-olds

Subject -No.	Gender	Age (years; months)	Lang. spoken with the mother	Lang. spoken with the father	Lang. spoken with sib-lings
1	M	7	T	T	X
2	M	7;6	T	T	G
3	M	7;6	G	G	X
4	M	7;5	T	T	T
5	M	7;4	G	T	T/G
6	M	7;8	T	T	X
7	F	7;2	T	T	T/G
8	F	7;5	T	T	X
9	F	6;5	T	T	G
10	F	6;8	T	G	G
11	M	6;8	T	T	G
12	F	7;7	T	T	G
13	M	7;1	T/G	T/G	X
14	M	6;11	T/G	T/G	X
15	M	7;7	T	T	T
16	F	6;11	T	T	G
17	F	7;8	T	T	G

[49] For the L1 10-year-olds we did not collect information on their birthday and thus only have their age expressed in years. Detailed information about age or language spoken at home is also not available.

[50] "X" means that participants had no siblings. Detailed information about the participants was collected through telephone conversations with their parents. In a few cases parents could not provide the precise age of onset of first exposure to the L2 suggesting that it took place sometime between ages 3 and 4.

10-year-olds

Subject-No.	Gender	Age	Language spoken with the mother[51]	Language spoken with the father	Language spoken with siblings
1	M	---	+ G/T	+ T/G	+ G/T
2	F	11	---	---	---
3	M	10	T	T	T
4	M	10	T	G	G
5	M	11	T/G	G	+ G/T
6	M	10	+ G/T	+ G/T	G
7	F	11	+ G/T	T	+ G/T
8	M	11	+ T/G	G	T
9	M	10	+ G/T	+ T/G	G
10	M	10	T	G	T/G
11	M	10	+ T/G	+ T/G	G
12	M	10	G	+ T/G	G
13	M	10	T	T	G
14	F	10	---	---	---
15	F	10	T	G	+ G/T
16	F	11	T	T	+ T/G
17	F	10	---	---	---
18	F	9	---	---	---
19	M	10	G	T	X
20	M	11	T	T	X
21	M	11	+ T/G	+ T/G	+ G/T
22	F	11	+ T/G	+ T/G	+ G/T
23	F	9	+ T/G	+ T/G	+ T/G
24	F	10	---	---	---

[51] "+" indicates that one of the two languages is spoken more than the other.

A.3 Information about the L1 7-year-olds from the study on OVS sentences

Unambiguous OVS sentences

Subject-No.	Gender	Age (years; months)
1	M	7;8
2	M	7;6
3	M	7;6
4	F	7;1
5	F	7;5
6	F	7;4
7	M	7;8
8	F	7;6
9	M	7;5
10	F	7;1

Temporarily ambiguous OVS sentences

Subject-No.	Gender	Age (years; months)
1	F	6;7
2	M	7;6
3	F	7;6
4	F	7;3
5	F	7;1
6	F	7;6
7	F	7;6
8	M	6;11
9	F	7;8
10	F	---

A.4 Information about the L2 7-year-olds from the study on OVS sentences

Unambiguous OVS sentences

Subject-No.	Gender	Age (years; months)	First Language	Language spoken with the mother	Language spoken with the father	Language spoken with sib-lings
1	F	7;3	T	T	T	G/T
2	F	7;6	T	T	T	G/T
3	M	6;8	T	T	T	G/T
4	F	6;10	T	T/G	T/G	X
5	M	6;8	T	T	T	X
6	M	6;6	T	T	T	G/T
7	M	7;6	T	T	T	G/T
8	F	7	T	T	T	T
9	F	6;9	T	T	T	T
10	M	6;3	T	T	T	X
11	M	7	T	T	T	X

Temporarily ambiguous OVS sentences

Subject-No.	Gender	Age (years; months)	Language spoken with the mother	Language spoken with the father	Language spoken with sib-lings
1	F	6;6	T	T	T/G
2	M	7;1	T/G	T/G	G
3	M	7;3	T	T	G
4	M	6;10	T	T	X
5	M	7;4	T	T/G	X
6	M	6;7	T	T	X
7	F	---	---	---	---
8	F	---	---	---	---
9	M	---	---	---	---

Appendix B: Experimental material

B.1 Full set of experimental items separated into the four lists for the study on active/passive sentences

List 1

Item-No.	Sentence Type	Item	Agent position
1	Active	Der Opa hat am Abend die Oma ganz kurz gekitzelt *The grandpa has tickled the grandma in the evening very shortly*	Left
2	Active	Der Opa hat am Sonntag die Oma liebevoll geküsst *The grandpa has kissed the grandma on Sunday affectionately*	Right
3	Active	Der Mann hat am Montag die Frau ganz doll getreten *The man has powerfully kicked the woman on Monday*	Left
4	Active	Der Mann hat am Freitag die Frau ein bisschen gestreichelt *The man has caressed the woman a little on Friday*	Right
5	Passive	Der Mann wurde am Samstag von der Frau in der Früh gehauen *The man was beaten by the woman on Saturday morning*	Left
6	Passive	Der Mann wurde am Dienstag von der Frau mit Absicht geschubst . *The man was pushed by the woman with intention on Tuesday*	Right
7	Passive	Der Opa wurde am Mittag von der Oma aus Versehen geweckt *The grandpa was by accident awakened by the grandma*	Left
8	Passive	Der Opa wurde in der Nacht von der Oma sehr lange gewaschen *The grandpa was washed by the grandma very long in the night*	Right
9	Active	Der Vater hat in der Nacht die Mutter liebevoll gekitzelt *The father has caressed the mother affectionately in the night*	Left

10	Active	Der Vater hat am Abend die Mutter sehr lange geküsst *The father has kissed the mother in the evening very long*	Right
11	Active	Der Bruder hat am Dienstag die Schwester mit Absicht getreten *The brother has kicked the sister on Tuesday with intention*	Left
12	Active	Der Bruder hat am Samstag die Schwester ganz kurz gewaschen *The brother has washed the sister on Saturday very shortly*	Right
13	Passive	Der Bruder wurde am Montag von der Schwester in der Früh gehauen *The brother was beaten by the sister on Monday very early*	Left
14	Passive	Der Bruder wurde am Freitag von der Schwester ganz doll geschubst *The brother was powerfully pushed by the sister on Friday*	Right
15	Passive	Der Vater wurde am Sonntag von der Mutter aus Versehen geweckt *The father was awakened accidentally by the mother on Sunday*	Left
16	Passive	Der Vater wurde am Mittag von der Mutter ein bisschen gestreichelt *The father was caressed by the mother a little on Friday*	Right

List 2

Item-No.	**Sentence Type**	**Item**	**Agent position**
1	Passive	Der Opa wurde am Abend von der Oma ganz kurz gekitzelt	Left
2	Passive	Der Opa wurde am Sonntag von der Oma liebevoll geküsst	Right
3	Passive	Der Mann wurde am Montag von der Frau ganz doll getreten	Left
4	Passive	Der Mann wurde am Freitag von der Frau ein bisschen gestreichelt	Right
5	Active	Der Mann hat am Samstag die Frau in der Früh gehauen	Left
6	Active	Der Mann hat am Dienstag die Frau mit Absicht geschubst	right
7	Active	Der Opa hat am Mittag die Oma aus Versehen geweckt	left
8	Active	Der Opa hat in der Nacht die Oma sehr lange gewaschen	right

9	Passive	Der Vater wurde in der Nacht von der Mutter liebevoll gekitzelt	left
10	Passive	Der Vater wurde am Abend von der Mutter sehr lange geküsst	right
11	Passive	Der Bruder wurde am Dienstag von der Schwester mit Absicht getreten	left
12	Passive	Der Bruder wurde am Samstag von der Schwester ganz kurz gewaschen	right
13	Active	Der Bruder hat am Montag die Schwester in der Früh gehauen	left
14	Active	Der Bruder hat am Freitag die Schwester ganz doll geschubst	right
15	Active	Der Vater hat am Sonntag die Mutter aus Versehen geweckt	left
16	Active	Der Vater hat am Mittag die Mutter ein bisschen gestreichelt	right

List 3

Item-No.	Sentence Type	Item	Agent position
1	Active	Die Oma hat am Abend den Opa ganz kurz gekitzelt	left
2	Active	Die Oma hat am Sonntag den Opa liebevoll geküsst	right
3	Active	Die Frau hat am Montag den Mann ganz doll getreten	left
4	Active	Die Frau hat am Freitag den Mann ein bisschen gestreichelt	right
5	Passive	Die Frau wurde am Samstag von dem Mann in der Früh gehauen	left
6	Passive	Die Frau wurde am Dienstag von dem Mann mit Absicht geschubst	right
7	Passive	Die Oma wurde am Mittag von dem Opa aus Versehen geweckt	left
8	Passive	Die Oma wurde in der Nacht von dem Opa sehr lange gewaschen	right
9	Active	Die Mutter hat in der Nacht den Vater liebevoll gekitzelt	left
10	Active	Die Mutter hat am Abend den Vater sehr lange geküsst	right
11	Active	Die Schwester hat am Dienstag den Bruder mit Absicht getreten	left
12	Active	Die Schwester hat am Samstag den Bruder ganz kurz gewaschen	right
13	Passive	Die Schwester wurde am Montag von dem Bruder in der Früh gehauen	left
14	Passive	Die Schwester wurde am Freitag von dem Bruder ganz doll geschubst	right

15	Passive	Die Mutter wurde am Sonntag von dem Vater aus Versehen geweckt	left
16	Passive	Die Mutter wurde am Mittag von dem Vater ein bisschen gestreichelt	right

List 4

Item Number	Sentence Type	Item	Agent position
1	Passive	Die Oma wurde am Abend von dem Opa ganz kurz gekitzelt	left
2	Passive	Die Oma wurde am Sonntag von dem Opa liebevoll geküsst	right
3	Passive	Die Frau wurde am Montag von dem Mann ganz doll getreten	left
4	Passive	die Frau wurde am Freitag von dem Mann ein bisschen gestreichelt	right
5	Active	Die Frau hat am Samstag den Mann in der Früh gehauen	left
6	Active	Die Frau hat am Dienstag den Mann mit Absicht geschubst	right
7	Active	Die Oma hat am Mittag den Opa aus Versehen geweckt	left
8	Active	Die Oma hat in der Nacht den Opa sehr lange gewaschen	right
9	Passive	Die Mutter wurde in der Nacht von dem Vater liebevoll gekitzelt	left
10	Passive	Die Mutter wurde am Abend von dem Vater sehr lange geküsst	right
11	Passive	Die Schwester wurde am Dienstag von dem Bruder mit Absicht getreten	left
12	Passive	Die Schwester wurde am Samstag von dem Bruder ganz kurz gewaschen	right
13	Active	Die Schwester hat am Montag den Bruder in der Früh gehauen	left
14	Active	Die Schwester hat am Freitag den Bruder ganz doll geschubst	right
15	Active	Die Mutter hat am Sonntag den Vater aus Versehen geweckt	left
16	Active	Die Mutter hat am Mittag den Vater ein bisschen gestreichelt	right

B.2 Full set of warm-up and filler-items

Warm-up items

Item-No.	Item	Target picture position
1	Das ist der Opa *This is the granpa*	Left
2	Das ist die Oma *This is the grandma*	Right
3	Das ist der Mann *This is the man*	Right
4	Das ist die Frau *This is the woman*	Left
5	Das ist der Vater *This is the father*	Left
6	Das ist die Mutter *This is the mother*	Right
7	Das ist der Bruder *This is the brother*	Right
8	Das ist Peter *This is Peter*	Left
9	Das ist Katrin *This is Katrin*	Right

Filler-items

Item-No.	Item	Target picture position
1	Peter wollte am Wochenende einen schönen Pilz/eine schöne Kirsche kaufen *Peter wanted to buy a beatiful mushroom/cherry in the weekend*	right/left
2	Sara wollte im Supermarkt einen leckeren Apfel/eine leckere Banane kaufen *Sara wanted to buy a tasty apple/banana at the supermarket*	left/right
3	Der Junge wollte im Garten einen runden Kürbis/eine runde Melone essen *The boy wanted to eat a round pumpkin/melon in the garden*	right/left
4	Das Mädchen wollte zu Hause einen frischen Salat/eine frische Tomate essen *The girl wanted to eat a fresh salad/tomato at home*	left/right
5	Daniel wollte im Zoo einen großen Elefanten/eine große Giraffe ansehen *Daniel wanted to see a big elephant/giraffe at the zoo*	right/left
6	Anna wollte im Zirkus einen echten Tiger/eine echte Schlange ansehen *Anna wanted to see a real tiger/snake in the circus*	left/right
7	Der Junge wollte auf der Strasse einen lieben Hund/ eine liebe Katze füttern *The boy wanted to feed a lovely dog/cat on the street*	right/left
8	Das Mädchen wollte auf der Wiese einen kleinen Vogel/eine kleine Schildkröte füttern *The girl wanted to feed a little bird/turtle in the meadow*	left/right
9	Markus musste in der Schule einen Kuchen backen *Markus should bake a cake in the school*	Right
10	Sandra sollte im Sommer ein Kleid zerschneiden *Sandra had to cut a dress in the sommer*	Left
11	Der Junge musste am Strand ein Schloss bauen *The boy had to build a castle on the beach*	right
12	Der Junge sollte in den Ferien das Zimmer aufräumen *The boy should tide the room in the holidays*	left

13	Lukas sollte im Sommer die Wäsche draussen waschen *Lukas should wash the laundry outside in the sommer*	right
14	Katrin musste den Boden im Hotel putzen *Katrin had to clean the floor in the hotel*	left
15	Das Mädchen sollte vor dem Schlafen Milch trinken *The girl should drink milk before the sleep*	right
16	Das Mädchen musste auf der Party eine Hose tragen *The girl had to wear the trousers at the party*	left

B.3 Full set of experimental items separated into the four lists for the study on SVO/OVS sentences

Early disambiguated sentences

List 1

Item-No.	Sentence Type	Item	Agent position
1	OVS	Den Opa hat am Abend die Oma ganz kurz gekitzelt *The grandpa (ACC.MASC.) has tickled the grandma (NOM.FEM.) in the evening very shortly*	right
2	SVO	Der Opa hat am Sonntag die Oma liebevoll geküsst *The grandpa (NOM.MASC.) has kissed the grandma (ACC.FEM.) on Sunday affectionately*	right
3	OVS	Den Opa hat am Mittag die Oma aus Versehen geweckt *The grandpa (ACC.MASC.) has by accident awakened the grandma (NOM.FEM.)*	left
4	SVO	Der Opa hat in der Nacht die Oma sehr lange gewaschen *The grandpa (NOM.MASC.) has washed the grandma (ACC.FEM.) very long in the night*	left
5	OVS	Den Mann hat am Samstag die Frau in der Früh gehauen *The man (ACC.MASC.) has beaten the woman (NOM.FEM.) on Saturday morning*	right
6	SVO	Der Mann hat am Dienstag die Frau mit Absicht geschubst *The man (NOM.MASC.) has pushed the woman (ACC.FEM.) with intention on Tuesday*	right
7	OVS	Den Mann hat am Montag die Frau ganz doll getreten *The man (ACC.MASC.) has powerfully kicked the woman (NOM.FEM.) on Monday*	left
8	SVO	Der Mann hat am Freitag die Frau ein bisschen gestreichelt *The man (NOM.MASC.) has caressed the woman (ACC.FEM.) a little on Friday*	left
9	SVO	Der Vater hat in der Nacht die Mutter liebevoll gekitzelt *The father (NOM.MASC.) has caressed the mother (ACC.FEM.) affectionately in the night*	left
10	OVS	Den Vater hat am Abend die Mutter sehr lange geküsst *The father (ACC.MASC.) has kissed the mother (NOM.FEM.) in the evening very long*	left

11	SVO	Der Vater hat am Sonntag die Mutter aus Versehen geweckt *The father (NOM. MASC.) has awaekened accidentally the mother (ACC.FEM.) on Sunday*	right
12	OVS	Den Vater hat am Mittag die Mutter ein bisschen gestreichelt *The father (ACC.MASC.) has caressed the mother (NOM.FEM.) a little on Friday*	right
13	SVO	Der Bruder hat am Montag die Schwester in der Früh gehauen *The brother (NOM.MASC.) has beaten the sister (ACC.FEM.) on Monday very early*	left
14	OVS	Den Bruder hat am Freitag die Schwester ganz doll geschubst *The brother (ACC.MASC.) has powerfully pushed the sister (NOM.FEM.) on Friday*	left
15	SVO	Der Bruder hat am Dienstag die Schwester mit Absicht getreten *The brother (NOM.MASC.) has kicked the sister (ACC.FEM.) on Tuesday with intention*	right
16	OVS	Den Bruder hat am Samstag die Schwester ganz kurz gewaschen *The brother (ACC.MASC.) has washed the sister (NOM.FEM.) on Saturday very shortly*	right

List 2

Item-No.	**Sentence Type**	**Item**	**Agent position**
1	SVO	Der Opa hat am Abend die Oma ganz kurz gekitzelt	left
2	OVS	Den Opa hat am Sonntag die Oma liebevoll geküsst	right
3	SVO	Der Opa hat am Mittag die Oma aus Versehen geweckt	left
4	OVS	Den Opa hat in der Nacht die Oma sehr lange gewaschen	right
5	SVO	Der Mann hat am Samstag die Frau in der Früh gehauen	left
6	OVS	Den Mann hat am Dienstag die Frau mit Absicht geschubst	right
7	SVO	Der Mann hat am Montag die Frau ganz doll getreten	left
8	OVS	Den Mann hat am Freitag die Frau ein bisschen gestreichelt	right
9	OVS	Den Vater hat in der Nacht die Mutter liebevoll gekitzelt	left
10	SVO	Der Vater hat am Abend die Mutter sehr lange geküsst	right
11	OVS	Den Vater hat am Sonntag die Mutter aus Verse-	left

		hen geweckt	
12	SVO	Der Vater hat am Mittag die Mutter ein bisschen gestreichelt	right
13	OVS	Den Bruder hat am Montag die Schwester in der Früh gehauen	left
14	SVO	Der Bruder hat am Freitag die Schwester ganz doll geschubst	right
15	OVS	Den Bruder hat am Dienstag die Schwester mit Absicht getreten	left
16	SVO	Der Bruder hat am Samstag die Schwester ganz kurz gewaschen	right

Late disambiguated sentences

List 1

Item Number	**Sentence Type**	**Item**	**Agent´s position**
1	OVS	Die Oma hat am Abend den Opa ganz kurz gekitzelt *The grandma (ACC.FEM.) has tickled the grandpa (NOM.MASC.) in the evening very shortly*	left
2	SVO	Die Oma hat am Sonntag den Opa liebevoll geküsst *The grandma (NOM.FEM.) has kissed the grandpa (ACC.MASC.) on Sunday affectionately*	left
3	OVS	Die Oma hat am Mittag der Opa aus Versehen geweckt *The grandma (ACC.FEM.) has by accident awakened the grandpa (NOM.MASC.)*	right
4	SVO	Die Oma hat in der Nacht den Opa sehr lange gewaschen *The grandma (NOM.FEM.) has washed the grandpa (ACC.MASC.) very long in the night*	right
5	OVS	Die Frau hat am Samstag den Mann in der Früh gehauen *The woman (ACC.FEM.) has beaten the man (NOM.MASC.) on Saturday morning*	left
6	SVO	Die Frau hat am Dienstag den Mann mit Absicht geschubst *The woman (NOM.FEM.) has pushed the man (ACC.MASC.) with intention on Tuesday*	left
7	OVS	Die Frau hat am Montag den Mann ganz doll getreten *The woman (ACC.FEM.) has powerfully kicked the man (NOM.FEM.) on Monday*	right

8	SVO	Die Frau hat am Freitag den Mann ein bisschen gestreichelt *The woman (NOM.FEM.) has caressed the man (ACC.MASC.) a little on Friday*	right
9	SVO	Die Mutter hat in der Nacht den Vater liebevoll gekitzelt *The mother (NOM.FEM.) has caressed the father (ACC.MASC.) affectionately in the night*	right
10	OVS	Die Mutter hat am Abend den Vater sehr lange geküsst *The mother (ACC.FEM.) has kissed the father (NOM.MASC.) in the evening very long*	Right
11	SVO	Die Mutter hat am Sonntag den Vater aus Versehen geweckt *The mother (NOM.FEM.) has awaekened accidentally the father (ACC.MASC.) on Sunday*	Left
12	OVS	Die Mutter hat am Mittag den Vater ein bisschen gestreichelt *The mother (ACC.FEM.) has caressed the father (NOM.MASC.) a little on Friday*	Left
13	SVO	Die Schwester hat am Montag den Bruder in der Früh gehauen *The sister (NOM.FEM.) has beaten the brother (ACC.MASC.) on Monday very early*	Right
14	OVS	Die Schwester hat am Freitag den Bruder ganz doll geschubst *The sister (ACC.FEM.) has powerfully pushed the brother (NOM.MASC.) on Friday*	Right
15	SVO	Die Schwester hat am Dienstag den Bruder mit Absicht getreten *The sister (NOM.FEM.) has kicked the brother (ACC.MASC.) on Tuesday with intention*	Left
16	OVS	Die Schwester hat am Samstag den Bruder ganz kurz gewaschen *The sister (ACC.FEM.) has washed the brother (NOM.MASC.) on Saturday very shortly*	Left

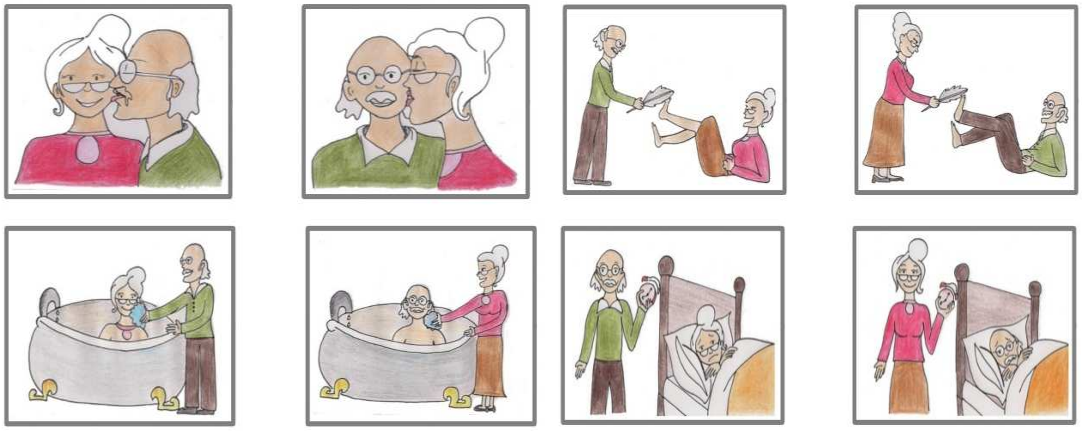
List 2

Item-No.	Sentence Type	Item	Agent position
1	SVO	Die Oma hat am Abend den Opa ganz kurz gekitzelt	Right
2	OVS	Die Oma hat am Sonntag der Opa liebevoll geküsst	Right
3	SVO	Die Oma hat am Mittag den Opa aus Versehen geweckt	Left
4	OVS	Die Oma hat in der Nacht der Opa sehr lange gewaschen	Left
5	SVO	Die Frau hat am Samstag den Mann in der Früh gehauen	Right
6	OVS	Die Frau hat am Dienstag der Mann mit Absicht geschubst	Right
7	SVO	Die Frau hat am Montag den Mann ganz doll getreten	Left
8	OVS	Die Frau hat am Freitag der Mann ein bisschen gestreichelt	Left
9	OVS	Die Mutter hat in der Nacht den Vater liebevoll gekitzelt	Left
10	SVO	Die Mutter hat am Abend der Vater sehr lange geküsst	Left
11	OVS	Die Mutter hat am Sonntag den Vater aus Versehen geweckt	Right
12	SVO	Die Mutter hat am Mittag der Vater ein bisschen gestreichelt	Right
13	OVS	Die Schwester hat am Montag den Bruder in der Früh gehauen	Left
14	SVO	Die Schwester hat am Freitag der Bruder ganz doll geschubst	Links
15	OVS	Die Schwester hat am Dienstag den Bruder mit Absicht getreten	Right
16	SVO	Die Schwester hat am Samstag der Bruder ganz kurz gewaschen	Right

B.4 Full set of visual stimuli for the study on active/passive and SVO/OVS sentences

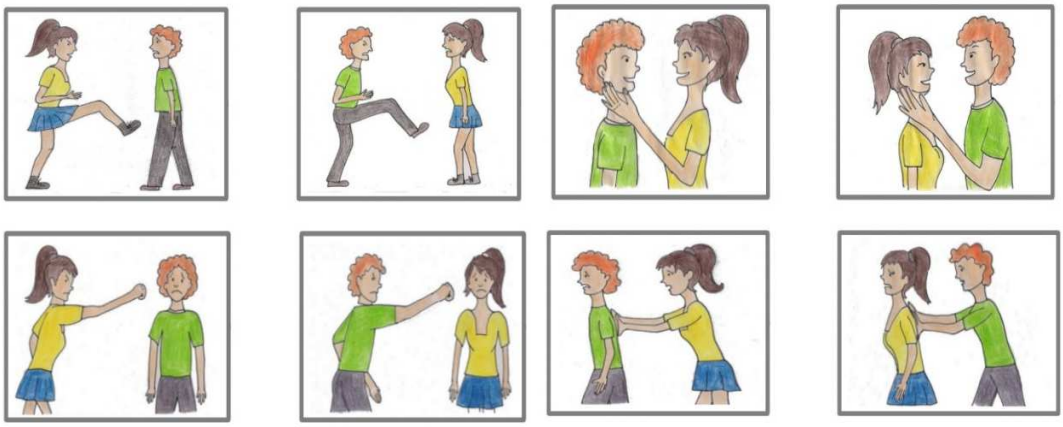
Experimental items

Protagonists: grandpa/grandma; Actions: kiss, tickle, wash, wake up



Protagonists: father/mother; Actions: kiss, tickle, caress, wake up

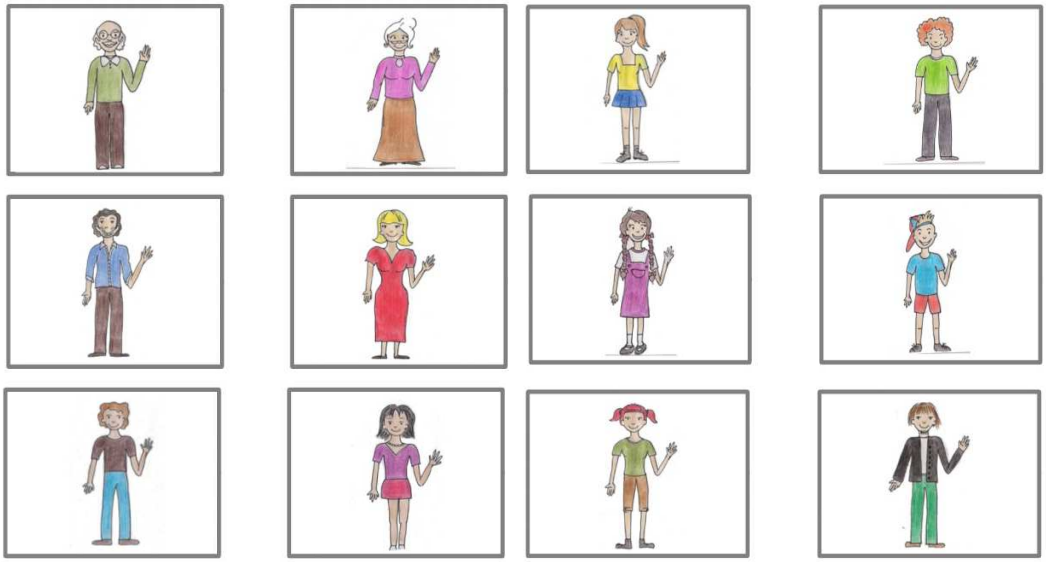
Protagonists: man/woman; Actions: kick off, caress, beat, push



Protagonists: brother/sister; Actions: beat, push, kick off, wash

Warm-up items

Protagonists: grandpa/grandma, woman/man, father/mother, sister/brother, boy/girl, Katrin/Peter



Filler-items

Appendix C: Proficiency tests

C.1 C-Test for the 10-year-olds

1. Die Zaubermurmeln

Es war einmal ein Junge, der hieß Leo. Zu seinem acht_____ Geburtstag schenkte i_____ seine Mutter ei_____ Beutel mit Mur_____ . Aber sie wus_____ nicht, dass e_____ Zaubermurmeln waren. Le_____ ging damit i_____ eine Zoohandlung. E_____ sah sich Papag_____ an.

So sch_____ Flügel müsste m_____ haben, dachte e_____ und nahm da_____ eine rote Mur_____ in die Hand. Schwupp, da wuch_____ ihm rote Flü_____. Schnell flog e_____ wieder nach Hau_____ . „Hilfe!“, schrie seine Mutter. „Was kommt denn da geflogen?“ „Ich bin’s doch!“, rief Leo.

2. Der neugierige Drache

Es war einmal ein grüner Drache. Der grüne Dra_____ fand unterwegs ei_____ Paket. Neugierig öff_____ der Drache d_____ Paket. Darin w_____ ein Schlüssel. Die_____ passte in ei_____ altes, kapu_____ Schloss. Das Sch_____ verschloss eine Ki_____ .

Der kleine gr_____ Drache drehte u_____ drehte, bis d_____ Schloss endlich aufkl_____ und er s_____ öffnen konnte.

I_____ der Kiste l_____ ein Spiegel. E_____ zeigte ihm ei_____ neugieriges Ges_____ .

3. Viererbande

Unsere Klasse nennt sich die Viererbande. Aber keine Angst, wir sind nicht der Schrecken der Schule! Wir si_____ gegen Gewalt. Au_____ dem Schulhof versu_____ wir kleinere u_____ schwächere Kinder z_____ beschützen. Wir fin_____ es ungerecht, we_____ sie umgestoßen wer_____ und erklären d_____ Angreifer, dass e_____ gemein ist, and_____ wehzutun. Unsere vi_____ wichtigen Regeln hei_____ :

1. Nicht drohen, sond_____ bitten!
2. Nicht kämp_____, sondern widersprechen!
3. E_____ ist nicht feige sich zu entschu_____ .
4. Es ist kl_____ , dem Feind zu verzeihen.

Willst du nicht in unserer Bande mitmachen?

C.2 C-Test for the 7-year-olds

	Grammatical Item	* Ungrammatical Item
Nominal Case Marking	*Der Polizist fährt* ***mit dem Auto*** The policeman drives with (+ DAT.) the car *Die Eltern singen* ***mit den Kindern*** The parents sing with (+ DAT.) the children *Lukas badet* ***mit der Ernte*** Lukas bathes with (+ DAT.) the duck	* *Die Tante spielt* ***mit die Tiere (mit DEN TiereN)*** The aunt plays with the animals * *Sarah schreibt* ***mit der roten Stift (mit DEM roten Stift)*** Sarah writes with the red pen * *Markus isst* ***mit dem Gabel (mit DER Gabel)*** Markus eats with the fork
Adjective Inflection	*Der Bäcker trägt* ***ein buntes T-Shirt*** The baker wears a colourful t-shirt (ADJ. STRONG INFL.) Die Mutter kuschelt **das kleine Kind** The mother cuddles the litte kid (ADJ. WEAK INFL.) *Katrin hat* ***ein weisses Kaninchen*** Katrin has a white bunny (ADJ. STRONG INFL.)	* *Der Prinz hat* ***eines schönen Schloss (EIN SCHÖNES Schloss)*** The prince has a beatiful castle * *Die Frau füttert* ***das liebes Pferd (das LIEBE Pferd)*** The woman feeds the gentle horse * *Das ist* ***eines interessante Buch (ein interessantes Buch)*** This is an interesting book
Subject-Verb Agreement	***Der Mann fährt*** *zum Bauernhof* The man drives to the farm (VERB: 3rd P.SING.) ***Anna spaziert*** *in der Stadt* Anna walks in the city (VERB: 3rd P.SING.) *Die zwei* ***Kinder schlafen*** *im Zelt* The two children sleep in the tent (VERB: 3rd P.PLUR.)	**** Die Frösche schwimmt*** *im Wasser (****der Frosch*** *oder* ***schwimmen****)* The frogs swim in the water **** Der schwarze Hund bellen*** *laut (****bellet*** *oder* ***der Hund****)* The black dog barks loudly ***Die Mäuse riecht*** *den Käse (****riechen*** *oder* ***die Maus****)* The mouses smell the cheese
Word Order	*Im blauen Meer* ***schwimmt der Opa*** In the blue sea swims the grandpa (VERB: 2nd POSITION) *Im Sommer* ***isst das Mädchen*** *Eis* In the summer eats the girl ice *Auf dem Tisch* ***steht eine Torte*** On the table stands the cake	* *Im grünen Wald* ***der Vater jagt (jagt*** *der Vater)* In the green wood the father hunts * *Im Winter* ***die Oma trinkt*** *Tee (****trinkt*** *die Oma)* In the winter the grandma drinks tea * *Im Theater* ***der Junge tanzt (tanzt*** *der Junge)* In the theater the young boy dances

Appendix D: Statistics of the eye movement data[52]

D.1 Statistical results of Study 1, Experiment 1 (chapter 2); L1 adults, 7-year-olds and 10-year-olds

SEGMENT 1	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)	Group	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)	Sentence Type		Estimate	Std.Error	z value	Pr(>|z|)
	(Intercept)	1,38	0,10	14,15	< 2e-16 ***	7-year-olds	(Intercept)	1,25	0,18	6,81	9.94e-12 ***	active	(Intercept)	1,11	0,22	5,09	3.51e-07 ***
	Image	0,16	0,13	1,22	0,22		Image	0,25	0,16	1,55	0,12		Image	0,36	0,26	1,36	0,17
	Age1	0,34	0,12	2,77	0.005608 **		Sentence Type	0,26	0,08	3,06	0.00222 **	passive	(Intercept)	1,47	0,15	9,65	<2e-16 ***
	Age2	0,39	0,12	3,30	0.000965 ***		Image*Sentence Type	-0,34	0,07	-4,69	2.73e-06 ***		Image	-0,14	0,26	-0,53	0,60
	Sentence Type	0,21	0,05	4,00	6.48e-05 ***	10-year-olds	(Intercept)	1,72	0,07	23,01	<2e-16 ***						
	Image*Age1	-0,24	0,17	-1,46	0,14		Image	-0,01	0,13	-0,05	0,96						
	Image*Age2	-0,24	0,17	-1,46	0,14		Sentence Type	0,00	0,05	-0,10	0,92						
	Image*Sentence Type	-0,32	0,07	-4,49	7.24e-06 ***		Image*Sentence Type	-0,02	0,06	-0,40	0,69						
	Age1:Sentence Type	-0,21	0,07	-3,00	0.002703 **	Adults	(Intercept)	1,77	0,07	25,11	< 2e-16 ***	active	(Intercept)	1,72	0,10	17,18	<2e-16 ***
	Age2:Sentence Type	-0,37	0,07	-5,48	4.27e-08 ***		Image	-0,10	0,14	-0,74	0,46		Image	-0,11	0,21	-0,52	0,60
	Image*Age1*Sentence Type	0,29	0,09	3,09	0.002032 **		Sentence Type	-0,18	0,05	-3,88	0.000105 ***	passive	(Intercept)	1,54	0,11	13,99	<2e-16 ***
	Image*Age2*Sentence Type	0,65	0,09	7,05	1.84e-12 ***		Image*Sentence Type	0,36	0,06	6,29	3.13e-10 ***		Image	0,26	0,20	1,32	0,19
SEGMENT 2	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Sentence Type**	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**						
part 1	(Intercept)	1,97	0,07	29,90	< 2e-16 ***	active	(Intercept)	0,91	0,12	7,43	1.07e-13 ***						
200-500	Image	-0,49	0,11	-4,42	9.74e-06 ***		Image	-0,20	0,21	-0,97	0,33						
	Age1	0,31	0,08	3,77	0.000161 ***		Age1	0,46	0,15	3,02	0.00256 **						
	Age2	0,36	0,08	4,22	2.41e-05 ***		Age2	0,40	0,15	2,66	0.00791 **						
	Sentence Type	-0,30	0,05	-5,49	3.94e-08 ***		Image*Age1	0,00	0,27	-0,01	0,99						
	Image*Age1	-0,07	0,14	-0,46	0,64		Image*Age2	0,23	0,26	0,88	0,38						
	Image*Age2	-0,11	0,14	-0,81	0,42	passive	(Intercept)	0,56	0,17	3,33	0.000885 ***						
	Image*Sentence Type	0,80	0,06	12,54	< 2e-16 ***		Image	0,67	0,19	3,56	0.000367 ***						
	Age1:Sentence Type	-0,04	0,07	-0,61	0,54		Age1	0,54	0,18	3,06	0.002232 **						
	Age2:Sentence Type	0,07	0,07	1,08	0,28		Age2	0,62	0,19	3,25	0.001158 **						
	Image*Age1*Sentence Type	-0,0889	0,11958	-0,744	0,457084		Image*Age1	-0,47	0,25	-1,92	0.054433 .						
	Image*Age2*Sentence Type	-0,1623	0,09646	-1,682	0,09250 .		Image*Age2	-0,35	0,24	-1,44	0,15						
part 2	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Group**	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Sentence Type**		**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**
	(Intercept)	1,49	0,09	16,04	< 2e-16 ***	7-year-olds	(Intercept)	1,35	0,08	17,09	<2e-16 ***	active	(Intercept)	1,24	0,12	10,30	<2e-16 ***
	Image	-0,15	0,14	-1,06	0,29		Image	-0,01	0,05	-0,15	0,88		Image	0,18	0,15	1,18	0,24
	Age1	0,31	0,11	2,74	0.00619 **		Sentence Type	-0,11	0,11	-0,99	0,32	passive	(Intercept)	1,18	0,13	8,87	<2e-16 ***
	Age2	0,36	0,11	3,20	0.00139 **		Image*Sentence Type	0,20	0,02	9,97	<2e-16 ***		Image	-0,44	0,18	-2,51	0.0122 *
	Sentence Type	-0,34	0,06	-5,64	1.7e-08 ***	Adults	(Intercept)	1,75	0,02	91,70	< 2e-16 ***	active	(Intercept)	1,69	0,03	52,07	<2e-16 ***
	Image*Age1	-0,01	0,18	-0,07	0,95		Image	0,01	0,01	0,50	0,62		Image	0,11	0,11	1,05	0,29
	Image*Age2	-0,03	0,18	-0,16	0,87		Sentence Type	-0,01	0,06	-0,19	0,85	passive	(Intercept)	1,69	0,03	52,68	<2e-16 ***
	Image*Sentence Type	0,67	0,07	9,00	< 2e-16 ***		Image*Sentence Type	0,10	0,01	7,38	1.53e-13 ***		Image	-0,14	0,10	-1,38	0,17
	Age1:Sentence Type	0,67	0,07	9,00	< 2e-16 ***												
	Age2:Sentence Type	0,12	0,07	1,59	0,11												
	Image*Age1*Sentence Type	-0,15	0,10	-1,59	0,11												
	Image*Age2*Sentence Type	-0,27	0,09	-2,85	0.00440 **												
part 3	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Group**	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Sentence Type**		**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**
	(Intercept)	1,97	0,07	29,90	< 2e-16 ***	7-year-olds	(Intercept)	1,72	0,07	24,20	<2e-16 ***	active	(Intercept)	1,48	0,11	13,07	<2e-16 ***
	Image	-0,49	0,11	-4,42	9.74e-06 ***		Image	0,05	0,08	0,64	0,52		Image	0,35	0,16	2,14	0.0327 *
	Age1	0,36	0,08	4,22	2.41e-05 ***		Sentence Type	-0,06	0,05	-1,19	0,23	passive	(Intercept)	1,73	0,10	18,09	<2e-16 ***
	Age2	0,31	0,08	3,77	0.000161 ***		Image*Sentence Type	0,21	0,02	12,48	<2e-16 ***		Image	-0,22	0,10	-2,13	0.0329 *
	Sentence Type	-0,30	0,05	-5,49	3.94e-08 ***	Adults	(Intercept)	2,03	0,02	130,65	< 2e-16 ***	active	(Intercept)	1,95	0,04	55,67	< 2e-16 ***
	Image*Age1	-0,07	0,14	-0,46	0,64		Image	0,17	0,06	2,92	0.00351 **		Image	0,34	0,10	3,45	0.000565 ***
	Image*Age2	-0,11	0,14	-0,81	0,42		Sentence Type	-0,01	0,02	-0,70	0,48	passive	(Intercept)	2,00	0,02	94,80	<2e-16 ***
	Image*Sentence Type	0,80	0,06	12,54	< 2e-16 ***		Image*Sentence Type	0,13	0,01	10,69	< 2e-16 ***		Image	0,04	0,09	0,47	0,64
	Age1:Sentence Type	0,80	0,06	12,54	< 2e-16 ***												
	Age2:Sentence Type	0,07	0,07	1,08	0,28												
	Image*Age1*Sentence Type	-0,14	0,08	-1,65	0.099139 .												
	Image*Age2*Sentence Type	-0,29	0,08	-3,61	0.000305 ***												
SEGMENT 3	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Group**	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Sentence Type**		**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**
part 1	(Intercept)	2.315826	0.071366	32.45	< 2e-16 ***	7-year-olds	(Intercept)	2,30	0,09	24,63	< 2e-16 ***	active	(Intercept)	2,26	0,12	18,58	< 2e-16 ***
	Image	-0,83	0,14	-5,88	4.09e-09 ***		Image	-0,88	0,20	-4,40	1.09e-05 ***		Image	-1,28	0,37	-3,48	0.00051 ***
	Age1	0,25	0,09	2,90	0.003741 **		Sentence Type	0,04	0,07	0,63	0,53	passive	(Intercept)	2,29	0,13	17,34	< 2e-16 ***
	Age2	0,31	0,09	3,64	0.000275 ***		Image*Sentence Type	-0,26	0,06	-4,18	2.95e-05 ***		Image	-1,50	0,39	-3,84	0.000122 ***
	Sentence Type	0,06	0,05	1,23	0,22	10-year-olds	(Intercept)	2,55	0,06	39,55	< 2e-16 ***	active	(Intercept)	2,53	0,08	31,68	< 2e-16 ***
	Image*Age1	-0,08	0,18	-0,47	0,64		Image	-0,95	0,19	-5,07	3.89e-07 ***		Image	-1,03	0,23	-4,39	1.11e-05 ***
	Image*Age2	0,00	0,17	-0,01	0,99		Sentence Type	0,17	0,04	4,18	2.94e-05 ***	passive	(Intercept)	2,71	0,06	43,22	< 2e-16 ***
	Image*Sentence Type	-0,23	0,06	-3,77	0.000164 ***		Image*Sentence Type	-0,49	0,05	-8,88	< 2e-16 ***		Image	-6,86	0,34	-5,12	3.02e-07 ***
	Age1:Sentence Type	0,10	0,06	1,69	0.090965 .												
	Age2:Sentence Type	0,03	0,06	0,62	0,54												
	Image*Age1*Sentence Type	-0,21	0,08	-2,53	0.011315 *												
	Image*Age2*Sentence Type	-0,13	0,08	-1,65	0.098293 .												
part 2						**Sentence Type**											
	(Intercept)	2,31	0,08	29,98	< 2e-16 ***	active	(Intercept)	2,24	0,13	17,45	< 2e-16 ***						
	Image	-1,14	0,17	-6,62	3.65e-11 ***		Image	-1,38	0,26	-5,34	9.57e-08 ***						
	Age1	0,35	0,10	3,60	0.000319 ***		Age1	0,42	0,15	2,92	0.003463 **						
	Age2	0,45	0,10	4,53	5.80e-06 ***		Age2	0,52	0,14	3,84	0.000121 ***						
	Sentence Type	0,07	0,04	1,64	0,1014		Image*Age1	-0,09	0,31	-0,74	0,46						
	Image*Age1	-0,20	0,21	-0,93	0,3531		Image*Age2	-0,23	0,31	-0,74	0,46						
	Image*Age2	-0,38	0,21	-1,84	0.065883 .	passive	(Intercept)	2,35	0,10	23,14	< 2e-16 ***						
	Image*Sentence Type	-0,19	0,07	-2,91	0.003650 **		Image	-1,56	0,28	-5,50	3.89e-08 ***						
	Age1:Sentence Type	0,01	0,06	0,15	0,8844		Age1	0,41	0,10	3,95	7.96e-05 ***						
	Age2:Sentence Type	-0,04	0,05	-0,71	0,4792		Age2	0,44	0,11	3,96	7.60e-05 ***						
	Image*Age1*Sentence Type	-0,09	0,09	-1,05	0,2935		Image*Age1	-0,35	0,37	-0,93	0,35						
	Image*Age2*Sentence Type	0,08	0,09	0,93	0,3503		Image*Age2	-0,32	0,36	-0,88	0,38						
SEGMENT 4	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Group**	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Sentence Type**		**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**
	(Intercept)	1,91	0,11	16,86	< 2e-16 ***	7-year-olds	(Intercept)	1,90	0,12	15,83	< 2e-16 ***	active	(Intercept)	1,89	0,12	15,13	< 2e-16 ***
	Image	-2,10	0,38	-5,48	4.27e-08 ***		Image	-2,90	0,67	-4,34	1.42e-05 ***		Image	-3,16	0,73	-4,32	1.55e-05 ***
	Age1	0,43	0,15	2,84	0.00453 **		Sentence Type	0,08	0,12	0,68	0,50	passive	(Intercept)				
	Age2	-19,38	310,61	-0,06	0,9503		Image*Sentence Type	-1,08	0,12	-8,86	< 2e-16 ***		Image				
	Sentence Type	0,09	0,13	0,74	0,4568	10-year-olds	(Intercept)	2,35	0,05	50,37	<2e-16 ***	active	(Intercept)				
	Image*Age1	-0,14	0,44	-0,33	0,7432		Image	-2,15	0,26	-8,37	<2e-16 ***		Image				
	Image*Age2	19,65	310,61	0,06	0,9496		Sentence Type	0,00	0,04	-0,07	0,95	passive	(Intercept)				
	Image*Sentence Type	-1,03	0,12	-8,75	< 2e-16 ***		Image*Sentence Type	-0,07	0,09	-0,80	0,43		Image				
	Age1:Sentence Type	-0,09	0,17	-0,54	0,5920												
	Age2:Sentence Type	0,16	427,67	0,00	0,9997												
	Image*Age1*Sentence Type	-0,01	427,67	0,00	1,00												
	Image*Age2*Sentence Type	0,94	0,15	6,36	2.06e-10 ***												

[52] Differences between the statistical analyses among the studies concerning the same group can be detected. These are due to different versions of R as well as different comparisons leading to different models with or without random slopes.

D.2 Statistical results of Study 2, Experiment 2.1 (chapter 3); L1 and L2 10-year-olds

SEGMENT 1	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)
200-500	(Intercept)	1.77	0.03	56.60	<2e-16 ***
	Language	0.11	0.04	2.50	0.0124 *
	Image	-0.02	0.04	-0.45	0.65
	Sentence Type	-0.01	0.04	-0.20	0.84
	Language*Image	-0.07	0.06	-1.13	0.26
	Language*Sentence Type	-0.11	0.06	-1.81	0.0707 .
	Image*Sentence Type	-0.02	0.06	-0.25	0.80
	Language*Image*Sentence Type	0.13	0.09	1.46	0.14

SEGMENT 2	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)	Sentence Type	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)
part 1	(Intercept)	1.45	0.04	39.76	< 2e-16 ***	active	(Intercept)	1.43	0.03	56.22	< 2e-16 ***
0-200	Language	-0.03	0.05	-0.64	0.52		Image	-0.13	0.04	-3.40	0.000682 ***
	Image	-0.21	0.05	-3.89	0.000101 ***	passive	(Intercept)	1.21	0.03	39.85	< 2e-16 ***
	Sentence Type	-0.24	0.05	-4.42	1.01e-05 ***		Image	0.28	0.04	7.35	2.05e-13 ***
	Language*Image	0.16	0.07	2.12	0.034398 *						
	Language*Sentence Type	0.03	0.08	0.39	0.70						
	Image*Sentence Type	0.39	0.08	5.13	2.89e-07 ***						
	Language*Image*Sentence Type	0.03	0.11	0.28	0.78						

part 2	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)	Group	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)	Sentence Type	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)
200-900	(Intercept)	2.80	0.03	109.10	< 2e-16 ***	L1 children	(Intercept)	2.80	0.03	95.43	<2e-16 ***	active	(Intercept)	2.80	0.03	85.11	<2e-16 ***
	Language	0.07	0.03	1.94	0.05236 .		Image	-0.39	0.03	-13.70	<2e-16 ***		Image	-0.39	0.03	-13.70	<2e-16 ***
	Image	-0.39	0.03	-13.70	< 2e-16 ***		Sentence Type	-0.31	0.03	-11.35	<2e-16 ***	passive	(Intercept)	2.48	0.04	68.00	< 2e-16 ***
	Sentence Type	-0.31	0.03	-11.37	< 2e-16 ***		Image*Sentence Type	0.57	0.04	14.20	<2e-16 ***		Image	0.18	0.03	6.40	1.52e-10 ***
	Language*Image	-0.09	0.04	-2.28	0.02232 *	L2 children	(Intercept)	2.87	0.02	116.77	<2e-16 ***	active	(Intercept)	2.86572	0.02246	127.60	<2e-16 ***
	Language*Sentence Type	-0.11	0.04	-2.81	0.00494 **		Image	-0.48	0.03	-16.74	<2e-16 ***		Image	-0.48	0.03	-16.73	<2e-16 ***
	Image*Sentence Type	0.57	0.04	14.20	< 2e-16 ***		Sentence Type	-0.42	0.03	-14.85	<2e-16 ***	passive	(Intercept)	2.44	0.03	86.93	<2e-16 ***
	Language*Image*Sentence Type	0.27	0.06	4.70	2.61e-06 ***		Image*Sentence Type	0.84	0.04	20.66	<2e-16 ***		Image	0.36	0.03	12.48	<2e-16 ***

SEGMENT 3	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)	Group	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)	Sentence Type		Estimate	Std.Error	z value	Pr(>|z|)
part 1	(Intercept)	2.59	0.03	91.68	< 2e-16 ***	L1 children	(Intercept)	2.59	0.03	77.26	< 2e-16 ***	active	(Intercept)	2.54	0.06	43.22	<2e-16 ***
200-700	Language	0.13	0.04	3.44	0.000586 ***		Image	-0.83	0.04	-22.85	< 2e-16 ***		Image	-0.80	0.04	-22.04	<2e-16 ***
	Image	-0.83	0.04	-22.90	< 2e-16 ***		Sentence Type	0.14	0.03	5.05	4.52e-07 ***	passive	(Intercept)	2.74	0.03	95.19	<2e-16 ***
	Sentence Type	0.14	0.03	5.03	4.80e-07 ***		Image*Sentence Type	-0.41	0.05	-7.77	8.16e-15 ***		Image	-1.25	0.04	-31.87	<2e-16 ***
	Language*Image	-0.23	0.05	-4.48	7.50e-06 ***	L2 children	(Intercept)	2.72	0.02	111.70	<2e-16 ***						
	Language*Sentence Type	-0.16	0.04	-4.20	2.72e-05 ***		Image	-1.06	0.04	-28.40	<2e-16 ***						
	Image*Sentence Type	-0.41	0.05	-7.75	9.32e-15 ***		Sentence Type	-0.03	0.03	-0.94	0.35						
	Language*Image*Sentence Type	0.48	0.08	6.41	1.46e-10 ***		Image*Sentence Type	0.07	0.05	1.29	0.20						

part 2	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)	Sentence Type	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)
700-1200	(Intercept)	2.70	0.03	89.97	< 2e-16 ***	active	(Intercept)	2.73	0.03	100.89	<2e-16 ***
	Language	0.08	0.04	1.96	0.0497 *		Image	-1.23	0.03	-44.12	<2e-16 ***
	Image	-1.23	0.04	-30.86	< 2e-16 ***	passive	(Intercept)	2.74	0.05	59.33	< 2e-16 ***
	Sentence Type	0.07	0.03	2.53	0.0113 *		Image	-2.00	0.26	-7.80	6.2e-15 ***
	Language*Image	-0.01	0.06	-0.16	0.87						
	Language*Sentence Type	-0.06	0.04	-1.49	0.14						
	Image*Sentence Type	-0.25	0.06	-4.39	1.15e-05 ***						
	Language*Image*Sentence Type	0.08	0.08	0.96	0.34						

SEGMENT 4	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)
200-500	(Intercept)	2.35	0.04	54.81	<2e-16 ***
	Language	-0.03	0.05	-0.69	0.49
	Image	-2.06	0.21	-9.88	<2e-16 ***
	Sentence Type	0.00	0.03	-0.10	0.92
	Language*Image	-0.04	0.08	-0.53	0.60
	Language*Sentence Type	0.34	0.25	1.37	0.17
	Image*Sentence Type	0.07	0.05	1.48	0.14
	Language*Image*Sentence Type	-0.17	0.12	-1.41	0.16

D.2 Statistical results of Study 2, Experiment 2.2 (chapter 3); L1 and L2 7-year-olds

SEGMENT 1	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)	Group	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)	Sentence Type		Estimate	Std.Error	z value	Pr(>|z|)
200-500	(Intercept)	1.300	0.147	8.849	< 2e-16 ***	active	(Intercept)	1.191	0.146	8.175	2.96e-16 ***						
	Language	-0.052	0.215	-0.242	0.809		Image	0.285	0.201	1.416	0.157						
	Image	0.206	0.158	1.306	0.191	passive	(Intercept)	1.474	0.119	12.353	<2e-16 ***						
	Sentence Type	0.239	0.086	2.771	0.00558 **		Image	-0.259	0.210	-1.234	0.217						
	Language*Image	0.093	0.221	0.422	0.673												
	Language*Sentence Type	-0.014	0.113	-0.126	0.899												
	Image*Sentence Type	-0.344	0.074	-4.641	3.47e-06 ***												
	Language*Image*Sentence Type	-0.225	0.117	-1.921	0.05474 .												
SEGMENT 2	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Sentence Type**	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**						
part 1	(Intercept)	0.999	0.082	12.184	< 2e-16 ***	L1 children	(Intercept)	0.993	0.089	11.144	< 2e-16 ***	active	(Intercept)	0.974	0.104	9.401	<2e-16 ***
0-200	Language	0.023	0.104	0.217	0.829		Image	-0.036	0.065	-0.550	0.583		Image	-0.037	0.065	-0.565	0.572
	Image	-0.036	0.065	-0.552	0.581		Sentence Type	-0.190	0.068	-2.791	0.00525 **	passive	(Intercept)	0.808	0.095	8.534	< 2e-16 ***
	Sentence Type	-0.181	0.068	-2.669	0.0076 **		Image*Sentence Type	0.474	0.091	5.190	2.1e-07 ***		Image	0.439	0.064	6.830	8.49e-12 ***
	Language*Image	-0.098	0.099	-0.986	0.324	L2 children	(Intercept)	1.028	0.090	11.478	<2e-16 ***						
	Language*Sentence Type	0.187	0.103	1.818	0.0690 .		Image	-0.134	0.075	-1.778	0.0753 .						
	Image*Sentence Type	0.475	0.091	5.188	2.12e-07 ***		Sentence Type	-0.003	0.077	-0.038	0.970						
	Language*Image*Sentence Type	-0.293	0.143	-2.057	0.0397 *		Image*Sentence Type	0.181	0.109	1.659	0.0971 .						
part 2	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Group**	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Sentence Type**		**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**
200-900	(Intercept)	2.470	0.068	36.490	< 2e-16 ***	L1 children	(Intercept)	2.476	0.069	36.100	<2e-16 ***	active	(Intercept)	0.974	0.104	9.401	<2e-16 ***
	Language	0.077	0.077	1.000	0.319		Image	-0.336	0.034	-9.930	<2e-16 ***		Image	-0.037	0.065	-0.565	0.572
	Image	-0.335	0.034	-9.910	< 2e-16 ***		Sentence Type	-0.297	0.034	-8.810	<2e-16 ***	passive	(Intercept)	1.954	0.198	9.883	<2e-16 ***
	Sentence Type	-0.294	0.034	-8.760	< 2e-16 ***		Image*Sentence Type	0.699	0.047	14.790	<2e-16 ***		Image	0.567	0.230	2.459	0.0139 *
	Language*Image	0.016	0.050	0.310	0.755	L2 children	(Intercept)	2.490	0.123	20.220	< 2e-16 ***	active	(Intercept)	2.460	0.146	16.856	<2e-16 ***
	Language*Sentence Type	-0.208	0.054	-3.860	0.000111 ***		Image	-0.312	0.198	-1.577	0.115		Image	-0.329	0.242	-1.361	0.173
	Image*Sentence Type	0.698	0.047	14.770	< 2e-16 ***		Sentence Type	-0.656	0.114	-5.752	8.84e-09 ***	passive	(Intercept)	1.446	0.399	3.625	0.000289 ***
	Language*Image*Sentence Type	0.148	0.074	2.000	0.045524 *		Image*Sentence Type	1.010	0.062	16.198	< 2e-16 ***		Image	0.908	0.522	1.740	0.081881 .
SEGMENT 3	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Group**	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Sentence Type**		**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**
part 1	(Intercept)	2.326	0.072	32.310	< 2e-16 ***	L1 children	(Intercept)	2.320	0.084	27.739	< 2e-16 ***	active	(Intercept)	2.259	0.122	18.581	< 2e-16 ***
200-700	Language	0.010	0.095	0.110	0.913		Image	-0.715	0.041	-17.481	< 2e-16 ***		Image	-1.283	0.369	-3.476	0.00051 ***
	Image	-0.715	0.041	-17.480	< 2e-16 ***		Sentence Type	0.052	0.033	1.572	0.116	passive	(Intercept)	2.210	0.154	14.363	< 2e-16 ***
	Sentence Type	0.054	0.033	1.640	0.101		**Image*Sentence Type**	-0.185	0.059	-3.125	0.00178 **		Image	-1.673	0.460	-3.636	0.000277 ***
	Language*Image	0.062	0.061	1.020	0.307	L2 children	(Intercept)	2.337	0.065	35.860	< 2e-16 ***						
	Language*Sentence Type	-0.169	0.053	-3.170	0.001546 **		Image	-0.653	0.045	-14.420	< 2e-16 ***						
	Image*Sentence Type	-0.185	0.059	-3.120	0.001783 **		Sentence Type	-0.117	0.042	-2.780	0.00546 **						
	Language*Image*Sentence Type	0.314	0.091	3.440	0.000574 ***		**Image*Sentence Type**	0.129	0.069	1.860	0.06256 .						
part 2	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Sentence Type**	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**						
700-1200	(Intercept)	2.32436	0.08585	27.076	< 2e-16 ***	L1 children	(Intercept)	2.325	0.090	25.892	< 2e-16 ***	active	(Intercept)	2.292	0.080	28.820	<2e-16 ***
	Language	-0.048	0.11148	-0.431	0.666287		Image	-0.922	0.043	-21.235	< 2e-16 ***		Image	-0.971	0.034	-28.960	<2e-16 ***
	Image	-0.922	0.04343	-21.230	< 2e-16 ***		Sentence Type	0.06247	0.03300	1.893	0.058324 .	passive	(Intercept)	2.359	0.103	23.013	< 2e-16 ***
	Sentence Type	0.06744	0.03281	2.055	0.039844 *		Image*Sentence Type	-0.214	0.063	-3.392	0.000694 ***		Image	-2.011	0.466	-4.316	1.59e-05 ***
	Language*Image	-0.121	0.06851	-1.766	0.077458 .	L2 children	(Intercept)	2.271	0.092	24.564	<2e-16 ***						
	Language*Sentence Type	-0.194	0.05451	-3.562	0.000368 ***		Image	-1.04	0.053	-19.693	<2e-16 ***						
	Image*Sentence Type	-0.214	0.06322	-3.391	0.000695 ***		Sentence Type	-0.126	0.043	-2.911	0.0036 **						
	Language*Image*Sentence Type	0.21169	0.10476	2.021	0.043312 *		**Image*Sentence Type**	-0.003	0.083	-0.033	0.974						
SEGMENT 4	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Group**	**Fixed Factors**	**Estimate**	**---**	**z value**	**Pr(>|z|)**	**Sentence Type**		**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**
200-500	(Intercept)	1.929	0.103	18.646	< 2e-16 ***	L1 children	(Intercept)	1.903	0.120	15.845	< 2e-16 ***	active	(Intercept)	1.880	0.131	14.407	< 2e-16 ***
	Language	-2.290	0.434	-5.277	1.31e-07 ***		Image	-3.047	0.688	-4.432	9.34e-06 ***		Image	-3.331	0.775	-4.297	1.73e-05 ***
	Image	0.052	0.098	0.526	0.599		Sentence Type	0.079	0.117	0.671	0.502	passive	(Intercept)	1.967	0.115	17.070	< 2e-16 ***
	Sentence Type	-0.317	0.152	-2.089	0.03666 *		Image*Sentence Type	-1.134	0.123	-9.252	< 2e-16 ***		Image	-5.123	0.782	-6.550	5.76e-11 ***
	Language*Image	-1.007	0.119	-8.457	< 2e-16 ***	L2 children	(Intercept)	1.646	0.089	18.585	< 2e-16 ***	active	(Intercept)	1.566	0.139	11.234	< 2e-16 ***
	Language*Sentence Type	0.835	0.584	1.429	0.153		Image	-0.80	0.067	-11.902	< 2e-16 ***		Image	-1.520	0.501	-3.033	0.00242 **
	Image*Sentence Type	0.120	0.142	0.848	0.396		Sentence Type	0.184	0.054	3.393	0.000693 ***	passive	(Intercept)	1.693	0.182	9.312	< 2e-16 ***
	Language*Image*Sentence Type	0.471	0.166	2.839	0.00453 **		Image*Sentence Type	-0.320	0.102	-3.137	0.001709 **		Image	-6.337	1.462	-4.336	1.45e-05 ***

D.3 Statistical results of Study 3, Exp. 3.1 (chapter 4); unambiguous SVO and OVS sentences; L1 adults and 7-year-olds

SEGMENT 1	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)	Group	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)	Sentence Type		Estimate	Std.Error	z value	Pr(>|z|)
200-500	(Intercept)	1.281	0.123	10.418	< 2e-16 ***	adults	(Intercept)	1.289	0.129	9.981	< 2e-16 ***	SVO	(Intercept)	1.217	0.183	6.665	2.65e-11 ***
	Age	0.067	0.168	0.399	0.690		Image	0.100	0.068	1.456	0.145		Image	-0.188	0.071	-2.631	0.00852 **
	Image	0.113	0.068	1.648	0.09929 .		Sentence Type	0.020	0.072	0.275	0.784	OVS	(Intercept)	1.304	0.104	12.575	<2e-16 ***
	Sentence Type	0.037	0.071	0.530	0.596		Image*Sentence Type	-0.288	0.099	-2.902	0.00371 **		Image	0.101	0.068	1.475	0.140
	Age*Image	-0.176	0.105	-1.679	0.09310 .	L1 children	(Intercept)	1.344	0.129	10.422	< 2e-16 ***	SVO	(Intercept)	1.243	0.145	8.587	< 2e-16 ***
	Age*Sentence Type	-0.123	0.106	-1.153	0.249		Image	-0.063	0.079	-0.795	0.427		Image	0.286	0.076	3.779	0.000157 ***
	Image*Sentence Type	-0.301	0.099	-3.033	0.00242 **		Sentence Type	-0.086	0.079	-1.078	0.281	OVS	(Intercept)	1.293	0.158	8.168	3.13e-16 ***
	Age*Image*Sentence Type	0.650	0.148	4.395	1.11e-05 ***		Image*Sentence Type	0.349	0.109	3.186	0.00144 **		Image	-0.063	0.079	-0.798	0.425
SEGMENT 2	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Sentence Type**	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**						
200-900	(Intercept)	2.598	0.175	14.839	< 2e-16 ***	adults	(Intercept)	2.560	0.176	14.531	< 2e-16 ***						
	Age	-0.364	0.231	-1.572	0.116		Image	-1.004	0.201	-4.996	5.84e-07 ***						
	Image	-0.907	0.174	-5.213	1.85e-07 ***		Sentence Type	-0.068	0.191	-0.354	0.723						
	Sentence Type	-0.100	0.122	-0.817	0.414		Image*Sentence Type	0.130	0.073	1.781	0.0749 .						
	Age*Image	0.716	0.239	2.996	0.00274 **	L1 children	(Intercept)	2.361	0.153	15.430	< 2e-16 ***	SVO	(Intercept)	2.344	0.190	12.360	<2e-16 ***
	Age*Sentence Type	0.226	0.166	1.361	0.174		Image	-0.288	0.049	-5.825	5.71e-09 ***		Image	-0.569	0.052	-10.850	<2e-16 ***
	Image*Sentence Type	0.143	0.069	2.074	0.03805 *		Sentence Type	0.048	0.045	1.061	0.289	OVS	(Intercept)	2.365	0.153	15.439	< 2e-16 ***
	Age*Image*Sentence Type	-0.538	0.101	-5.298	1.17e-07 ***		Image*Sentence Type	-0.281	0.072	-3.893	9.91e-05 ***		Image	-0.288	0.049	-5.833	5.45e-09 ***
SEGMENT 3	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Group**	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Sentence Type**	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**
part 1	(Intercept)	2.491	0.134	18.628	< 2e-16 ***	adults	(Intercept)	2.484	0.128	19.429	< 2e-16 ***	SVO	(Intercept)	2.024	0.191	10.589	< 2e-16 ***
200-700	Age	-0.155	0.183	-0.850	0.395		Image	-2.472	0.364	-6.786	1.15e-11 ***		Image	-2.015	0.554	-3.636	0.000277 ***
	Image	-2.386	0.320	-7.451	9.26e-14 ***		Sentence Type	-0.478	0.192	-2.487	0.0129 *	OVS	(Intercept)	2.477	0.001	2885.000	<2e-16 ***
	Sentence Type	-0.421	0.132	-3.193	0.001408 **		Image*Sentence Type	0.992	0.115	8.621	< 2e-16 ***		Image	-4.124	0.001	-4803.000	<2e-16 ***
	Age*Image	1.488	0.422	3.526	0.000421 ***	L1 children	(Intercept)	2.309	0.178	12.958	<2e-16 ***						
	Age*Sentence Type	0.175	0.171	1.022	0.307		Image	-0.912	0.387	-2.354	0.0186 *						
	Image*Sentence Type	1.077	0.108	9.956	< 2e-16 ***		Sentence Type	-0.246	0.167	-1.477	0.140						
	Age*Image*Sentence Type	-1.139	0.143	-7.976	1.51e-15 ***		Image*Sentence Type	-0.147	0.101	-1.449	0.148						
part 2	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)	Group	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)	Sentence Type	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)
700-1400	(Intercept)	2.892	0.110	26.335	< 2e-16 ***	adults	(Intercept)	2.860	0.114	25.073	< 2e-16 ***	SVO	(Intercept)	2.643	0.125	21.082	< 2e-16 ***
	Age	-0.231	0.146	-1.584	0.113		Image	-1.810	0.190	-9.516	< 2e-16 ***		Image	-1.731	0.385	-4.491	7.08e-06 ***
	Image	-1.933	0.239	-8.085	6.23e-16 ***		Sentence Type	-0.184	0.103	-1.785	0.0743 .	OVS	(Intercept)	2.832	0.130	21.712	< 2e-16 ***
	Sentence Type	-0.212	0.067	-3.168	0.00153 **		Image*Sentence Type	0.423	0.086	4.914	8.94e-07 ***		Image	-2.391	0.483	-4.955	7.23e-07 ***
	Age*Image	0.946	0.293	3.230	0.00124 **	L1 children	(Intercept)	2.648	0.160	16.514	< 2e-16 ***	SVO	(Intercept)	2.623	0.177	14.847	< 2e-16 ***
	Age*Sentence Type	0.238	0.075	3.166	0.00155 **		Image	-1.279	0.423	-3.023	0.0025 **		Image	-1.817	0.678	-2.678	0.00741 **
	Image*Sentence Type	0.560	0.083	6.761	1.37e-11 ***		Sentence Type	0.011	0.107	0.100	0.920	OVS	(Intercept)	2.623	0.177	14.847	< 2e-16 ***
	Age*Image*Sentence Type	-1.004	0.115	-8.772	< 2e-16 ***		Image*Sentence Type	-0.470	0.089	-5.273	1.34e-07 ***		Image	-1.817	0.678	-2.678	0.00741 **
part 3	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)	Sentence Type	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)	Sentence Type	Fixed Factors	Estimate	---	z value	Pr(>|z|)
1400-2100	(Intercept)	2.913	0.113	25.777	< 2e-16 ***	adults	(Intercept)	2.926	0.100	29.300	< 2e-16 ***	SVO	(Intercept)	2.774	0.097	28.730	<2e-16 ***
	Age	-0.521	0.129	-4.054	5.03e-05 ***		Image	-2.382	0.076	-31.545	< 2e-16 ***		Image	-1.686	0.060	-28.080	<2e-16 ***
	Image	-2.382	0.076	-31.536	< 2e-16 ***		Sentence Type	-0.149	0.034	-4.437	9.14e-06 ***	OVS	(Intercept)	2.909	0.117	24.940	<2e-16 ***
	Sentence Type	-0.139	0.033	-4.195	2.73e-05 ***		Image*Sentence Type	0.696	0.097	7.212	5.51e-13 ***		Image	-2.382	0.075	-31.580	<2e-16 ***
	Age*Image	2.016	0.091	22.182	< 2e-16 ***	L1 children	(Intercept)	2.364	0.151	15.708	< 2e-16 ***	SVO	(Intercept)	2.472	0.220	11.210	<2e-16 ***
	Age*Sentence Type	0.364	0.055	6.681	2.38e-11 ***		Image	-0.366	0.050	-7.259	3.89e-13 ***		Image	-1.111	0.058	-19.200	<2e-16 ***
	Image*Sentence Type	0.696	0.097	7.210	5.58e-13 ***		Sentence Type	0.225	0.043	5.201	1.98e-07 ***	OVS	(Intercept)	2.333	0.171	13.675	< 2e-16 ***
	Age*Image*Sentence Type	-1.441	0.123	-11.673	< 2e-16 ***		Image*Sentence Type	-0.745	0.077	-9.689	< 2e-16 ***		Image	-0.366	0.050	-7.271	3.58e-13 ***

D.3 Statistical results of Study 3, Experiment 3.2 (chapter 4); temporarily ambiguous SVO and OVS sentences; L1 adults and 7-year-olds

SEGMENT 1	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)	Group	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)	Sentence Type		Estimate	Std.Error	z value	Pr(>|z|)
200-500	(Intercept)	1.324	0.093	14.308	< 2e-16 ***	adults	(Intercept)	1.325	0.092	14.365	<2e-16 ***						
	Age	-0.369	0.124	-2.962	0.003058 **		Image	0.045	0.069	0.650	0.516						
	Image	0.044	0.069	0.645	0.519		Sentence Type	-0.103	0.072	-1.426	0.154						
	Sentence Type	-0.104	0.072	-1.438	0.150		Image*Sentence Type	0.042	0.100	0.420	0.675						
	Age*Image	0.715	0.108	6.627	3.43e-11 ***	L1 children	(Intercept)	0.943	0.117	8.052	8.13e-16 ***	SVO	(Intercept)	1.237	0.136	9.096	<2e-16 ***
	Age*Sentence Type	0.428	0.115	3.710	0.000207 ***		Image	0.760	0.083	9.142	< 2e-16 ***		Image	0.037	0.081	0.452	0.651
	Image*Sentence Type	0.042	0.100	0.423	0.672		Sentence Type	0.325	0.090	3.618	0.000297 ***	OVS	(Intercept)	0.956	0.111	8.634	<2e-16 ***
	Age*Image*Sentence Type	-0.765	0.153	-4.992	5.98e-07 ***		Image*Sentence Type	-0.723	0.116	-6.220	4.97e-10 ***		Image	0.760	0.083	9.155	<2e-16 ***
SEGMENT 2	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Sentence Type**	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Sentence Type**		**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**
part 1	(Intercept)	2.058	0.176	11.723	< 2e-16 ***	adults	(Intercept)	2.041	0.200	10.217	<2e-16 ***	SVO	(Intercept)	2.230	0.183	12.200	<2e-16 ***
200-900	Age	-0.144	0.231	-0.625	0.532		Image	0.284	0.234	1.216	0.224		Image	-0.508	0.365	-1.390	0.164
	Image	0.258	0.187	1.381	0.167		Sentence Type	0.217	0.112	1.941	0.0523 .	OVS	(Intercept)	1.842	0.298	6.176	6.56e-10 ***
	Sentence Type	0.230	0.093	2.474	0.0133 *		Image*Sentence Type	-0.635	0.070	-9.118	<2e-16 ***		Image	0.448	0.356	1.258	0.208
	Age*Image	0.384	0.242	1.589	0.112	L1 children	(Intercept)	2.012	0.093	21.670	<2e-16 ***	SVO	(Intercept)	2.488	0.086	28.952	<2e-16 ***
	Age*Sentence Type	0.299	0.125	2.383	0.0172 *		Image	0.587	0.051	11.618	<2e-16 ***		Image	-0.501	0.052	-9.662	<2e-16 ***
	Image*Sentence Type	-0.563	0.067	-8.467	< 2e-16 ***		Sentence Type	0.468	0.052	9.052	<2e-16 ***	OVS	(Intercept)	1.585	0.347	4.569	4.91e-06 ***
	Age*Image*Sentence Type	-0.555	0.099	-5.609	2.04e-08 ***		Image*Sentence Type	-1.089	0.072	-15.019	<2e-16 ***		Image	0.897	0.392	2.286	0.0223 *
SEGMENT 3	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Group**	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Sentence Type**	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**
part 1	(Intercept)	1.759	0.099	17.743	< 2e-16 ***	adults	(Intercept)	1.532	0.082	18.710	<2e-16 ***	SVO	(Intercept)	2.177	0.115	19.008	<2e-16 ***
200-700	Age	-0.660	0.141	-4.688	2.76e-06 ***		Image	0.732	0.041	17.950	<2e-16 ***		Image	-0.434	0.051	-8.582	<2e-16 ***
	Image	0.305	0.052	5.886	3.95e-09 ***		Sentence Type	0.707	0.041	17.250	<2e-16 ***	OVS	(Intercept)	1.724	0.134	12.877	< 2e-16 ***
	Sentence Type	0.436	0.051	8.588	< 2e-16 ***		Image*Sentence Type	-1.414	0.058	-24.570	<2e-16 ***		Image	0.305	0.052	5.899	3.65e-09 ***
	Age*Image	1.083	0.088	12.242	< 2e-16 ***	L1 children	(Intercept)	1.080	0.114	9.467	<2e-16 ***	SVO	(Intercept)	2.244	0.127	17.730	<2e-16 ***
	Age*Sentence Type	0.763	0.089	8.560	< 2e-16 ***		Image	1.388	0.072	19.367	<2e-16 ***		Image	-1.101	0.070	-15.740	<2e-16 ***
	Image*Sentence Type	-0.739	0.072	-10.197	< 2e-16 ***		Sentence Type	1.196	0.073	16.344	<2e-16 ***	OVS	(Intercept)	1.075	0.122	8.791	<2e-16 ***
	Age*Image*Sentence Type	-1.751	0.124	-14.148	< 2e-16 ***		Image*Sentence Type	-2.489	0.100	-24.831	<2e-16 ***		Image	1.388	0.072	19.398	<2e-16 ***
part 2	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Group**	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Sentence Type**	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**
700-1400	(Intercept)	2.188	0.097	22.626	< 2e-16 ***	adults	(Intercept)	2.224	0.088	25.150	< 2e-16 ***	SVO	(Intercept)	2.650	0.107	24.860	<2e-16 ***
	Age	0.125	0.130	0.961	0.336		Image	0.253	0.031	8.050	8.26e-16 ***		Image	-1.032	0.049	-21.100	<2e-16 ***
	Image	0.110	0.044	2.487	0.0129 *		Sentence Type	0.713	0.029	24.770	< 2e-16 ***	OVS	(Intercept)	2.166	0.101	21.502	<2e-16 ***
	Sentence Type	0.508	0.041	12.392	< 2e-16 ***		Image*Sentence Type	-1.385	0.046	-30.210	< 2e-16 ***		Image	0.110	0.044	2.491	0.0127 *
	Age*Image	0.284	0.063	4.507	6.59e-06 ***	L1 children	(Intercept)	2.301	0.125	18.388	<2e-16 ***	SVO	(Intercept)	2.977	0.326	9.138	<2e-16 ***
	Age*Sentence Type	0.397	0.058	6.835	8.21e-12 ***		Image	0.394	0.045	8.832	<2e-16 ***		Image	-1.215	0.046	-26.628	<2e-16 ***
	Image*Sentence Type	-1.142	0.066	-17.280	< 2e-16 ***		Sentence Type	0.893	0.041	21.750	<2e-16 ***	OVS	(Intercept)	2.320	0.109	21.245	<2e-16 ***
	Age*Image*Sentence Type	-0.467	0.092	-5.079	3.79e-07 ***		Image*Sentence Type	-1.609	0.064	-25.200	<2e-16 ***		Image	0.394	0.045	8.843	<2e-16 ***
part 3	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Sentence Type**	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**	**Sentence Type**	**Fixed Factors**	**Estimate**	**Std.Error**	**z value**	**Pr(>|z|)**
1400-2100	(Intercept)	2.319	0.106	21.884	< 2e-16 ***	adults	(Intercept)	2.324	0.092	25.337	< 2e-16 ***	SVO	(Intercept)	2.967	0.096	30.910	<2e-16 ***
	Age	-0.688	0.147	-4.670	3.02e-06 ***		Image	-0.271	0.046	-5.946	2.74e-09 ***		Image	-1.903	0.060	-31.740	<2e-16 ***
	Image	-0.271	0.046	-5.943	2.80e-09 ***		Sentence Type	0.682	0.043	15.693	< 2e-16 ***	OVS	(Intercept)	2.267	0.123	18.407	< 2e-16 ***
	Sentence Type	0.664	0.037	17.886	< 2e-16 ***		Image*Sentence Type	-1.632	0.075	-21.650	< 2e-16 ***		Image	-0.271	0.046	-5.954	2.61e-09 ***
	Age*Image	1.215	0.072	16.762	< 2e-16 ***	L1 children	(Intercept)	1.652	0.154	10.700	<2e-16 ***	SVO	(Intercept)	2.728	0.154	17.710	<2e-16 ***
	Age*Sentence Type	0.485	0.066	7.297	2.94e-13 ***		Image	0.944	0.056	16.770	<2e-16 ***		Image	-1.385	0.060	-23.090	<2e-16 ***
	Image*Sentence Type	-1.632	0.075	-21.638	< 2e-16 ***		Sentence Type	1.146	0.059	19.330	<2e-16 ***	OVS	(Intercept)	1.610	0.156	10.300	<2e-16 ***
	Age*Image*Sentence Type	-0.707	0.112	-6.339	2.32e-10 ***		Image*Sentence Type	-2.339	0.082	-28.460	<2e-16 ***		Image	0.944	0.056	16.800	<2e-16 ***

D.4 Statistical results of Study 4, Experiment 4.1 (chapter 5); unambiguous SVO and OVS sentences; L1 and L2 7-year-olds

SEGMENT 1	Group	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)
200-500	L1 children	(Intercept)	1.009	0.165	6.120	9.38e-10 ***
		Image	-0.038	0.101	-0.372	0.710
		Sentence Type	-0.223	0.186	-1.199	0.231
	L2 children	(Intercept)	1.296	0.114	11.403	<2e-16 ***
		Image	-0.018	0.065	-0.274	0.784
		Sentence Type	0.121	0.129	0.941	0.347

SEGMENT 2	Sentence Type	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)						
200-900	L1 children	(Intercept)	1.893	0.171	11.052	<2e-16 ***						
		Image	0.079	0.100	0.787	0.431						
		Sentence Type	0.324	0.146	2.222	0.0263 *						
		Image*Sentence Type	-0.026	0.124	-0.208	0.836						
	L2 children	(Intercept)	1.793	0.227	7.884	3.17e-15 ***	SVO	(Intercept)	1.521	0.349	4.355	1.33e-05 ***
		Image	0.251	0.125	2.014	0.04397 *		Image	0.729	0.270	2.701	0.00691 **
		Sentence Type	0.305	0.176	1.736	0.08261 .	OVS	(Intercept)	2.023	0.175	11.527	<2e-16 ***
		Image*Sentence Type	-0.408	0.157	-2.604	0.00922 **		Image	-0.081	0.226	-0.359	0.719

SEGMENT 3	Group	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)	Sentence Type	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)
part 1	L1 children	(Intercept)	2.309	0.178	12.958	<2e-16 ***						
200-700		Image	-0.912	0.387	-2.354	0.0186 *						
		Sentence Type	-0.246	0.167	-1.477	0.140						
		Image*Sentence Type	-0.147	0.101	-1.449	0.147						
	L2 children	(Intercept)	1.706	0.100	17.102	<2e-16 ***	SVO	(Intercept)	2.266	0.128	17.640	<2e-16 ***
		Image	0.555	0.057	9.733	<2e-16 ***		Image	-0.898	0.063	-14.350	<2e-16 ***
		Sentence Type	0.588	0.057	10.364	<2e-16 ***	OVS	(Intercept)	1.659	0.123	13.516	<2e-16 ***
		Image*Sentence Type	-1.452	0.085	-17.146	<2e-16 ***		Image	0.555	0.057	9.749	<2e-16 ***

part 2	Group	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)	Sentence Type	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)
700-1400	L1 children	(Intercept)	2.309	0.178	12.958	<2e-16 ***						
		Image	-0.912	0.387	-2.354	0.0186 *						
		Sentence Type	-0.246	0.167	-1.477	0.140						
		Image*Sentence Type	-0.147	0.101	-1.449	0.147						
	L2 children	(Intercept)	2.143	0.092	23.219	< 2e-16 ***	SVO	(Intercept)	2.544	0.114	22.410	<2e-16 ***
		Image	0.316	0.048	6.570	5.04e-11 ***		Image	-0.962	0.056	-17.180	<2e-16 ***
		Sentence Type	0.422	0.047	8.958	< 2e-16 ***	OVS	(Intercept)	2.120	0.108	19.657	< 2e-16 ***
		Image*Sentence Type	-1.278	0.074	-17.298	< 2e-16 ***		Image	0.316	0.048	6.578	4.77e-11 ***

part 3	Sentence Type	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)	Sentence Type	Fixed Factors	Estimate	---	z value	Pr(>|z|)
1400-2100	L1 children	(Intercept)	2.229	0.220	10.130	<2e-16 ***	SVO	(Intercept)	2.346	0.275	8.537	< 2e-16 ***
		Image	-0.590	0.397	-1.485	0.137		Image	-1.712	0.589	-2.908	0.00363 **
		Sentence Type	0.185	0.205	0.898	0.369	OVS	(Intercept)	1.980	0.403	4.919	8.72e-07 ***
		Image*Sentence Type	-0.835	0.089	-9.340	<2e-16 ***		Image	-0.766	0.775	-0.989	0.323
	L2 children	(Intercept)	2.023	0.089	22.712	< 2e-16 ***	SVO	(Intercept)	2.585	0.110	23.530	<2e-16 ***
		Image	0.370	0.050	7.392	1.45e-13 ***		Image	-1.129	0.058	-19.420	<2e-16 ***
		Sentence Type	0.587	0.048	12.190	< 2e-16 ***	OVS	(Intercept)	2.021	0.092	21.896	<2e-16 ***
		Image*Sentence Type	-1.499	0.077	-19.521	< 2e-16 ***		Image	0.370	0.050	7.401	1.35e-13 ***

D.4 Statistical results of Study 4, Experiment 4.2 (chapter 5); temporarily ambiguous SVO and OVS sentences; L1 and L2 7-year-olds

SEGMENT 1	Group	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)
200-500	L1 children	(Intercept)	1.089	0.118	9.230	<2e-16 ***
		Image	0.186	0.099	1.876	0.0606 .
		Sentence Type	-0.321	0.170	-1.885	0.0594 .
		Image*Sentence Type				
	L2 children	(Intercept)	1.142	0.129	8.870	< 2e-16 ***
		Image	0.234	0.056	4.162	3.16e-05 ***
		Sentence Type	-0.004	0.146	-0.028	0.978
		Image*Sentence Type				

SEGMENT 2	Sentence Type	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)						
200-900	L1 children	(Intercept)	2.001	0.139	14.370	<2e-16 ***	SVO	(Intercept)	1.960	0.140	13.970	<2e-16 ***
		Image	0.044	0.077	0.576	0.565		Image	0.356	0.222	1.609	0.108
		Sentence Type	-0.039	0.109	-0.364	0.716	OVS	(Intercept)	2.033	0.184	11.063	<2e-16 ***
		Image*Sentence Type	-0.397	0.173	-2.293	0.0218 *		Image	-0.448	0.196	-2.293	0.0218 *
	L2 children	(Intercept)	2.073	0.151	13.766	<2e-16 ***	SVO	(Intercept)				
		Image	0.015	0.081	0.179	0.858		Image				
		Sentence Type	0.193	0.144	1.342	0.179	OVS	(Intercept)				
								Image				

SEGMENT 3	Group	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)	Sentence Type	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)
part 1	L1 children	(Intercept)	1.048	0.149	7.036	1.98e-12 ***	SVO	(Intercept)	2.233	0.129	17.303	< 2e-16 ***
200-700		Image	1.382	0.190	7.274	3.49e-13 ***		Image	-1.923	0.509	-3.777	0.000159 ***
		Sentence Type	1.204	0.160	7.545	4.53e-14 ***	OVS	(Intercept)	0.410	0.432	0.948	0.343
		Image*Sentence Type	-2.711	0.130	-20.890	< 2e-16 ***		Image	2.037	0.460	4.426	9.6e-06 ***
	L2 children	(Intercept)	1.227	0.265	4.630	3.65e-06 ***	SVO	(Intercept)	0.410	0.432	0.948	0.343
		Image	0.935	0.309	3.029	0.00246 **		Image	2.037	0.460	4.426	9.6e-06 ***
		Sentence Type	0.632	0.234	2.698	0.00697 **	OVS	(Intercept)	0.830	0.386	2.151	0.0315 *
		Image*Sentence Type	-1.564	0.137	-11.437	< 2e-16 ***		Image	1.188	0.556	2.137	0.0326 *
part 2	Group	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)	Sentence Type	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)
700-1400	L1 children	(Intercept)	1.662	0.115	14.480	<2e-16 ***	SVO	(Intercept)	2.147	0.361	5.952	2.65e-09 ***
		Image	1.087	0.056	19.290	<2e-16 ***		Image	-0.699	0.445	-1.571	0.116
		Sentence Type	0.844	0.063	13.490	<2e-16 ***	OVS	(Intercept)	1.630	0.116	14.110	<2e-16 ***
		Image*Sentence Type	-1.609	0.076	-21.250	<2e-16 ***		Image	1.087	0.056	19.310	<2e-16 ***
	L2 children	(Intercept)	1.583	0.353	4.483	7.35e-06 ***	SVO	(Intercept)	1.630	0.116	14.110	<2e-16 ***
		Image	0.726	0.476	1.523	0.128		Image	1.087	0.056	19.310	<2e-16 ***
		Sentence Type	0.800	0.248	3.228	0.00125 **	OVS	(Intercept)	0.245	0.766	0.319	0.749
		Image*Sentence Type	-1.403	0.118	-11.871	< 2e-16 ***		Image	2.182	0.865	2.521	0.0117 *
part 3	Sentence Type	Fixed Factors	Estimate	Std.Error	z value	Pr(>|z|)	Sentence Type	Fixed Factors	Estimate	---	z value	Pr(>|z|)
1400-2100	L1 children	(Intercept)	1.652	0.154	10.700	<2e-16 ***	SVO	(Intercept)	2.784	0.141	19.720	<2e-16 ***
		Image	0.944	0.056	16.770	<2e-16 ***		Image	-1.396	0.060	-23.310	<2e-16 ***
		Sentence Type	1.146	0.059	19.330	<2e-16 ***	OVS	(Intercept)	1.610	0.156	10.300	<2e-16 ***
		Image*Sentence Type	-2.339	0.082	-28.460	<2e-16 ***		Image	0.944	0.056	16.800	<2e-16 ***
	L2 children	(Intercept)	1.824	0.439	4.158	3.21e-05 ***	SVO	(Intercept)	1.610	0.156	10.300	<2e-16 ***
		Image	0.473	0.498	0.951	0.342		Image	0.944	0.056	16.800	<2e-16 ***
		Sentence Type	0.731	0.394	1.857	0.0634 .	OVS	(Intercept)	0.183	0.775	0.236	0.814
		Image*Sentence Type	-1.672	0.116	-14.467	< 2e-16 ***		Image	2.163	0.836	2.587	0.00968 **