8 Strelau Temperament Inventory (STI): General Review and Studies Based on German Samples

Jan Strelau
University of Warsaw and University of Bielefeld

Alois Angleitner
University of Bielefeld

Willibald Ruch
University of Duesseldorf

Fifteen years have passed since the time the Strelau Temperament Inventory (STI) was first published in English (Strelau, 1972a). This questionnaire, aimed at diagnosing the Pavlovian nervous system properties, gained increasing popularity in the West after being published once again (Strelau, 1983) with more information comprising its psychometric characteristics—its construct validity in particular. The aim of this chapter is to present the accumulated results obtained with the STI and to introduce new results based on a broad study conducted on six German samples. In order to show how the STI is related to the Pavlovian theory of nervous system properties, a short introduction into this theory is given.

THE PAVLOVIAN NERVOUS SYSTEM PROPERTIES

It was in the first decades of this century when Pavlov, studying conditioned reflexes (CRs) in dogs, arrived at the conclusion that individual differences in the speed and efficiency of conditioning as well as in the dogs' behavior in laboratory surroundings can be explained by certain properties of the central nervous system (CNS). These properties include strength of excitation, strength of inhibition, the equilibrium of nervous processes (between strength of excitation and strength of inhibition), and their mobility. Depending on the configuration of those properties, different types of CNS may be distinguished. Pavlov, being under the influence of the ancient Greek temperament typology, limited the number of CNS types to four. He conceived of the types of the CNS as the physiological basis of temperament. However, these terms (i.e., types of the CNS and types of temperament) were used by him interchangeably, especially when referring to nervous system types in humans. "The mentioned types are what we call in man temperaments. The temperament constitutes the most general characteristic of every man, the most general and most essential characteristic of his nervous system" (Pavlov, 1952, p. 339).

In spite of the term "processes," which refers to excitation and inhibition through which strength, mobility and balance are characterized, the CNS properties should be regarded according to Pavlov as traits and not as states.

When defining the basic CNS properties Pavlov did not refer to the physiological mechanisms or processes underlying those properties, as may be expected from a physiologist. He described them from a functional point of view. Being under the influence of Darwin (see Windholz, 1987), Pavlov characterized the types of nervous system, as well as the CNS traits, taking into account the ability of the individual to adapt. This characteristic has been presented thoroughly elsewhere (Strelau, 1983), thus we will limit ourselves to a short description of the four Pavlovian basic CNS properties.

Strength of excitation refers to the functional capacity of the nervous system, thus to the ability of the cortical cells to work. It is manifested in the withstanding of either exceedingly strong, or prolonged excitation without slipping into protective (transmarginal) inhibition. The appearance of protective inhibition under strong, prolonged or recurrent stimulation, manifested in the decrease or in the disappearance of reactions to those stimuli, has been used by Pavlov as the main index of strength of excitation. Individuals in whom transmarginal inhibition occurs in reaction to stimuli of low intensity or duration are characterized as having a weak CNS, whereas individuals with a strong CNS are able to react adequately (i.e., without slipping into protective inhibition) to stimuli of high intensity and long duration. The strong type has a higher endurance (working capacity) of the CNS as compared with the weak CNS type. Because individuals are confronted in their every day lives with stimuli of great intensity, Pavlov considered the strength of excitation as the most important property of the nervous system (Pavlov, 1951–52).

The understanding by Pavlov of the concept of strength of inhibition was rather confused, owing to the fact that during his 30 years of research in the field of CNS types he often changed his view regarding this CNS property. In his last publications, especially in his paper *General Types of Higher Nervous Activity in Animals and Man* published in 1935, it became clear that strength of inhibition referred to conditioned (acquired) inhibition, that is, to those types of inhibition that are known as extinction, delay, differentiation, and conditioned inhibition (in its narrow sense). The strength of inhibition reveals itself in the ability to maintain a state of conditioned inhibition. The persistence of inhibition, that is, the amount of time a neuron can remain in an uninterrupted state of conditioned inhibition, is one of the basic indicators of that property. Individuals with weak inhibitory processes are unable to sustain conditioned inhibition for a long time, which results in disturbances in CR activity, including neurotic behavior. In individuals with a strong inhibitory process, prolonged conditioned inhibition does not cause disturbances. The ease of evoking inhibitory CRs and their stability are, according to Pavlov, the main indicators of the strength of inhibition. It has to be added that strength of inhibition has been measured almost exclusively only when equilibrium of the nervous processes was to be diagnosed. This statement holds true not only for Pavlov and his associates but also for his followers (Nebylitsyn, 1972a; Strelau, 1983; Teplov, 1964).

According to Pavlov the equilibrium of nervous processes should be regarded as the ratio of the strength of excitation to the strength of inhibition. As stressed by him, the functional meaning of this property consists of the ability to inhibit certain excitations, when required, in order to evoke other reactions in concert with the environmental demands. The followers of Pavlov have extended the equilibrium concept to other CNS properties. For example, Kupalov (1952) regarded equilibrium as a secondary trait that appears not only as a result of the ratio between strength of excitation and strength of inhibition, but also as the ratio of mobility of excitation to mobility of inhibition. Nebylitsyn (1972a) attributes to equilibrium the role of a general principle of organization of the CNS properties. According to him, this trait comprises strength, mobility, lability, and dynamism when the ratio between excitation and inhibition within those properties is characterized (see also Golubeva, 1980). The concept "equilibrium" or "balance" of CNS processes was and still is a source of many misunderstandings (Strelau, 1983).

Mobility of the nervous system was the last property to be discovered by Pavlov. It manifests itself in the ability to react quickly and adequately to changes in the surroundings. The essence of mobility is "the ability to give way—according to external conditions—to give priority to one impulse before the other, excitation before inhibition and conversely" (Pavlov, 1952, p. 540). The ability to respond adequately as soon as possible to continuous changes in the environment has to be distinguished from the speed with which nervous processes are initiated and terminated. For the latter characteristics the property labeled as lability has been proposed by Teplov (1963) and Nebylitsyn (1972a).

The basic properties of the CNS have to be regarded as explanatory concepts, which Pavlov related to the functions of the CNS in trying to explain the relatively stable individual differences in animals' CR activity and behavior (Strelau, 1983). Pavlov was interested above all in the objective examination (the salivary reflex conditioning paradigm) of the activity of the cerebral hemispheres in animals. His "physiological" approach to the CNS properties consists of interpreting certain forms of behavior, assumed to express temperamental traits, by using hypothetical neurophysiological constructs referring to the central nervous system. The research underlying his theory of higher nervous activity is centered primarily on the behavior (CR reactions) that he tried to explain by means of hypothesized mechanisms of the CNS. These mechanisms, however, have not been subject in Pavlov's laboratory to physiological or neurophysiological studies. Pavlov's research on behavior gives persuasive reason for recognizing him as a psychologist (Strelau, 1969, 1983; Watson, 1978; Windholz, 1987); his investigations on CNS properties may be regarded as the first laboratory studies in the field of temperament.

Since Pavlov was mainly interested in studying CRs, the conditioned reflex paradigm gained also the highest popularity when diagnosing the NSP in animals (e.g., Kolesnikov & Troshikhin, 1951). Also in the first studies conducted in humans, more exactly in children, the diagnosis of NS properties, and hence of types of CNS, was limited to CR activity (Ivanov-Smolensky, 1935; Krasnogorsky, 1953). The situation changed radically when Teplov and his followers started to investigate CNS properties in adults. Although still using the CR paradigm, mostly constrained to the so-called photochemical reflex (e.g., Rozhdestvenskaya, 1963) and to conditioned EEG alpha-blocking (Nebylitsyn, 1972a), they enlarged the number of phenomena on the basis of which CNS properties might be diagnosed. The sensitivity threshold, sensitivity restoration, adequate optical chronaxie, photic driving reaction, critical frequencies of flicker-fusion, click-fusion and flashing phosphene, and background alpha rhythm characteristics can be mentioned here as examples (see Nebylitsyn, 1972a; Strelau, 1983). Most of these phenomena refer to involuntary reactions. This is the consequence of one of the theses of the methodological "credo" formulated by the Moscow group (Teplov & Nebylitsyn, 1963). It says that it is essential to investigate the CNS properties by reference to involuntary movements in which these properties are clearly manifested, undisguised by the individual experience.

Soon thereafter the motor and/or verbal RT paradigm in diagnosing CNS properties became popular among the neo-Pavlovian typologists (Nebylitsyn, 1960, 1972a), though being in contradiction with the credo just mentioned. The RT paradigm has also been broadly used in other laboratories centered on studies of CNS properties (Kopytova, 1963; Peysakhov, 1974; Saprykin & Mileryan, 1954; Strelau, 1969, 1983; Troshikhin, Moldavskaya, & Kolchenko, 1978).

Parallel to the laboratory studies aimed at diagnosing CNS properties, the Pavlovian typologists have developed methods that allow the study of those properties in children and adolescents in natural settings. Most of these studies have been based on observations (e.g., Davydova, 1954; Leites, 1956) or on field experiments—different types of games, such as block building (Samarin, 1954), or "signalman" (Umansky, 1958) and "driver" (Chudnovsky, 1963), were arranged.

Physicians working in clinics and hospitals have undertaken attempts to diagnose the patients' nervous system properties on the basis of anamnesis and interviews. The contribution of Birman (1951), Cytawa (1959) and Pervomaysky (1964) should be mentioned here. All of these methods did not allow, however, for a quantitative measure of the nervous system properties.

As can be learned from the studies conducted by Pavlov and his students, the four CNS properties described earlier are not orthogonal to each other as some personality/temperament researchers would like them to be (Carlier, 1985; Eysenck, 1987; Stelmack, Kruidenier, & Anthony, 1985), and no such an assumption was made by the Pavlovian typologists. Let us consider the relationship between strength of excitation and mobility. In experiments conducted by Fedorov (1961) in mice, by Krasusky (1971) in dogs, and in studies aimed at diagnosing the CNS properties in man (Nebylitsyn, 1972a; Turovskaya, 1963) it became evident that strength of excitation is positively correlated with mobility of the nervous processes. To give one example, Troshikhin et al. (1978), in a study conducted on 225 subjects (aged from 5 to 24 years), stated that mobility correlates positively with strength of excitation from .51 to .83, depending on the developmental stage of the subjects (7 groups differing in age have been separated). In this study mobility was measured by the so-called alteration method and strength of excitation by means of the change of simple reaction time (RT) under repeatedly applied stimuli.[1]

NERVOUS SYSTEM PROPERTIES AND THE STRELAU TEMPERAMENT INVENTORY

On the basis of several experiments conducted during a period of over 15 years, Strelau (1972b) concluded that there exists a strongly limited generality in the diagnosis of CNS properties. The results show that the estimation of these properties depends on the modality of stimuli used (Nebylitsyn, 1972b; Strelau 1965a), on the type of reinforcements applied in CR experiments (Ivanov-Smolensky, 1935; Strelau, 1969), on the kind of reaction to be measured (Strelau, 1969, 1983), as well as on the criteria (indicators) on the basis of which the diagnosis is made (Strelau, 1983). These modality- and reaction-specific phenomena are also well known in studies on stress (Lacey, 1950, 1967) and currently in personality research based on the arousal concept (Fahrenberg, 1987; Fahrenberg, Walschburger, Foerster, Myrtek, & Mueller, 1983; Kohn, Cowles, & Lafreniere, 1987).

This rather pessimistic outcome in the diagnostic research on CNS properties

[1]These methods as well as most of the methods aimed at diagnosing the CNS properties distinguished by Pavlov and his followers are described in details by Strelau (1983, see also Mangan, 1982; Nebylitsyn, 1972a).

has led Strelau (1965b, 1969) to construct an observation chart, further developed into the Strelau Temperament Inventory (STI). The observation chart, based on a 4-point rating scale, is a kind of standard observation program, comprising 75 items that refer to various kinds of behavior and different situations. For each property, that is, for strength of excitation, strength of inhibition, and for mobility of nervous processes, 25 items were generated. The balance of nervous processes was estimated as the ratio between strength of excitation to strength of inhibition.

Situations and behaviors (supposed to indicate particular CNS properties) were selected upon an analysis of other methods for diagnosing the CNS properties in humans and, after examining Pavlov's theory of higher nervous activity, with special reference to the typology of the nervous system. It was the intention of the author to follow Pavlov's conceptualizations regarding the basic properties of the CNS as faithfully as possible. The properties have been defined in a way that Pavlov has understood them, without taking into account the modifications introduced by Teplov (1964) and Nebylitsyn (1972a). The main reason for not including the CNS properties as proposed by the neo-Pavlovian typologists into the research program was the lack of orthogonality of these traits against the original (Pavlovian) ones and their low consistency, as has been shown by Strelau (1983). This means, among other things, that the observation chart (and this holds true for the STI also) was aimed at measuring the strength of excitation, understood as the endurance of the nervous system. It does not comprise the sensitivity pole of the strength of excitation dimension, as it has been proposed by Teplov (1964) and Nebylitsyn (1972a). Mobility refers first of all to the ability to react adequately and quickly to changes in the surroundings, and not to the speed component present in the initiation and termination of nervous processes, the latter being comprised by lability, a property of the CNS introduced by the neo-Pavlovian typologists (see Nebylitsyn, 1972a; Teplov, 1972). Equilibrium of nervous processes does not take into account the ratio between excitation and inhibition in mobility (Kupalov, 1952) or in dynamism (Golubeva, 1980; Nebylitsyn, 1972a) but only in the strength of nervous processes, that is, as Pavlov has understood this trait.

We shall not go into the details of the observation chart here (see Strelau, 1965b, 1969). The first version of the STI was constructed in such a way as to be a duplicate of the observation chart, the difference consisting in the fact that, for each of the 75 items from this chart, one parallel item was generated. The answering format consisted in a 3-point rating scale. Thus the STI comprised 150 items, 50 for each of the three basic CNS properties. The first stage of research with the STI, with information regarding its reliability and validity, has been presented elsewhere (Strelau, 1972a). The item analysis of the first version of STI resulted in reformulating several items and in reducing their number to 134.

Finally, the second version of the STI, used since 1972 until now, comprises 134 items, 44 for strength of excitation (SE), 44 for strength of inhibition (SI), and 46 for mobility of nervous processes (M). Because the number of items for the SE scale and SI scale is equal, the balance of nervous processes may be indicated by the quotient of SE index divided by the SI index. Because the STI is based on a 3-point rating scale ("yes," "no," and "don't know") the maximum value of points to be received is 88 for both strength of excitation and strength of inhibition, and 92 for mobility of CNPs. A quotient higher than unity indicates the predominance of strength of excitation over strength of inhibition, whereas a quotient smaller than unity is an indicator of the reverse dominance.

Because a further parallel item was generated for each existing item in the observation chart, it was possible to construct two equivalent versions of the STI (A & B), both containing 67 items (22 for SE, 22 for SI, and 26 for M). These parallel versions were used mainly for measuring the internal consistency of the STI. In most of the studies the full version of the STI was applied.

It has to be remembered that in spite of the physiological terms used for labeling the properties to be measured by means of this inventory, the STI does not allow any insight into the physiological mechanisms to which these properties pertain. The STI refers to overt behavior, like most of the inventories do. The CNS properties have the status of explanatory concepts belonging to Pavlov's theory of higher nervous activity. This means that the STI is intended to measure temperamental traits, to be interpreted within the Pavlovian theory of types of the nervous system.

Because strength of the nervous system is expressed—according to Pavlov—by the ability to endure intense or long-lasting stimulation without passing into protective inhibition, the items comprising the SE scale refer to the following domains of behavior: (a) readiness for an action (activity) in highly stimulating situations; (b) carrying on activity in highly stimulating situations; (c) lack of emotional disturbances in stress situations (high load of stimulation); and (d) lack of evident changes in efficiency during conditions of intensive or long-lasting stimulation.

Regarding strength of inhibition as the functional capacity of the CNS for conditioned (learned) inhibition, especially as the ability to endure long-lasting conditioned inhibition, the items of the SI scale include such domains of behavior as (a) restraining from reactions; (b) delay of action; and (c) ability to interrupt an action.

All of the items included in the M scale refer to the ability to react quickly and adequately to changing conditions, which is the essence of mobility of the CNS according to Pavlov. A detailed ex post analysis of the items has shown, however, that some of the M scale items are rather bound with a more general temporal characteristic of behavior, including lability of the CNS.

It does not follow from Pavlov's theorizing whether or not the different CNS properties are related to each other. However, from the configurations of these properties in Pavlov's four types of the nervous system one may assume that they are conceptualized as rather being independent from each other.

NERVOUS SYSTEM PROPERTIES AS REPRESENTED IN THE STI AND OTHER PERSONALITY/TEMPERAMENT DIMENSIONS

The CNS properties to be represented by the STI scales (strength of excitation, strength of inhibition, mobility and balance between strength of excitation and inhibition) were partly subject to investigation by several authors. The aim of these studies was to explore the relationships between these properties and temperamental traits or biologically determined personality dimensions introduced by psychologists from the West. This section gives a short review of this research. As regards the empirical evidence for the relationships mentioned earlier, only those studies are included in which the Pavlovian CNS properties were measured on the basis of experimental methods, mainly developed by Teplov, Nebylitsyn, and their students. The data collected by means of the STI are presented in the following section.

The first attempts to relate CNS properties to other personality concepts stem from Pavlov (1951–52). In his studies on types of nervous systems he discovered that dogs with weak nervous processes are characterized by high anxiety, the latter being diagnosed on the basis of behavioral indicators. This hypothesis has been verified in several studies conducted in dogs (Kolesnikov, 1953; Krushinsky, 1947). In humans this relationship has been suggested by Nebylitsyn (1959) and Marton and Urban (1966). Taking into account the fact that in highly anxious individuals CRs to negative reinforcements are elaborated with higher speed than in nonanxious individuals (Spence, 1956), the authors hypothesized that high anxiety goes together with weak nervous processes. This is due to the weaks' high sensitivity of the nervous system which, in turn, determines the speed of conditioning. This idea has been further developed by Strelau (1969, 1983).

A significant step in searching for links between the CNS properties and personality dimensions has been done by Gray (1964). His reinterpretation of the concept of strength of the nervous system within the theory of arousal has stimulated personality researchers to study the relationships between this property of the CNS and personality dimensions based on the arousal concept. According to Gray, "the weak nervous system is more easily or more highly 'aroused'; and the personality dimension known as 'strength of the nervous system' could be described as a dimension of 'levels of arousal' or of 'arousability' " (1964, p. 289). This hypothesis has been used by Eysenck (1966; Eysenck & Levey, 1972) as well as by Gray (1967) in order to explain the relationship between strength of excitation and extraversion. Taking into account his reticulo-cortical arousal loop theory, Eysenck assumed that introverts and individuals with the weak CNS should be regarded as having generally higher levels of arousal as compared with the extravert and the strong type of the CNS. Some studies in which experimental measures of the strength of the nervous system have been used give evidence supporting this hypothesis. For example, Frigon (1976), using the EEG variant of the extinction with reinforcement method for diagnosing the strength of the nervous system and the EPI questionnaire for measuring extraversion, has found a positive correlation between extraversion and strength of the CNS. Similar results by using the same indicators of both dimensions were obtained by Gilliland (1985). Karpova (1974), using the slope of RT curve and the change of RT under repeatedly exposed stimuli for measuring strength of excitation and an undescribed method for diagnosing extraversion, reports a positive correlation between the two traits under discussion. There are, however, also data that do not support Eysenck's and Gray's "extraversion-strength of excitation" hypothesis. Loo (1979), using the slope of RT curve for measuring strength of excitation and the EPQ for diagnosing extraversion, stated that extraversion comprises one factor together with the weak CNS. Keuss and Orlebeke (1977), taking also the slope of RT curve as an indicator of strength and the MPI for measuring extraversion, obtained a negative correlation between both variables. A negative correlation between both dimensions under discussion was also obtained by Zhorov and Yermolayeva-Tomina (1972), who used the slope of RT curve and the MPI for diagnosing both strength and extraversion. Also, studies can be found that show that strength of excitation, as measured by laboratory techniques, and extraversion are not related to each other (Gupta & Nicholson, 1985; Kohn, 1987; Kohn et al., 1987). As can be easily stated, experimental studies of strength of the CNS as related to extraversion, the latter diagnosed by means of Eysenck's inventories, do not allow for unequivocal conclusion regarding the relationship between those two dimensions. One of the reasons for the lack of agreement may be the fact that extraversion is a very broad concept, comprising such diverse factors as sociability and impulsivity.

As described in detail elsewhere (Strelau, 1983) studies have also been conducted with the aim of establishing the relationship between experimentally measured mobility of the CNS and extraversion, with results not allowing a definite conclusion (see Loo, 1979; Mangan, 1967, 1978; Troshikhin et al., 1978). Research conducted in the last years suggests that extraversion and mobility, the latter measured in experimental settings, do not correlate with each other (see Dall & White, 1985; Rawlings, 1987).

The existence of a relationship between strength of the CNS and neuroticism has been suggested by Eysenck (1947) in the 1940s and almost 20 years later by Gray (1964). However, the latter author rejected this position. The reason for doing so was the fact that the sensory threshold has been regarded by the neo-Pavlovian typologists (see Nebylitsyn, 1972a; Teplov, 1964) as one of the main indicators of the strength of the nervous system, whereas neuroticism seems not to be related to sensory sensitivity. The hypothesized relationship between these two traits was subject to study in several experiments. Mangan and Farmer (1967) stated that strength of excitation, measured by means of the slope of RT curve, does not correlate with neuroticism as diagnosed with the MPI. This lack of correlation has been supported in other studies based on experimental indicators of the strength of the nervous system (Frigon, 1976; Karpova, 1974; Kovac & Halmiova, 1973; Orlebeke, 1972). An experiment conducted by Gupta and Nicholson (1985), where, among other things, the slope of RT curve was used for diagnosing strength of excitation, shows that neuroticism, as measured by the EPI, goes together with weak nervous processes. Keuss and Orlebeke (1977), also using the RT method for diagnosing strength, reported similar results.

Few studies have been conducted in which experimentally diagnosed mobility was related to neuroticism. The results are negative, that is, no relationship was found between the dimensions under discussion (Dall & White, 1985; Rawlings, 1987).

Aside from extraversion, neuroticism, and anxiety, further personality/temperament[2] dimensions have been confronted with the CNS properties under discussion. For example, Zuckerman (1979) has hypothesized that the basic nervous system properties, especially the strength of excitation, are related to sensation seeking. Using the absolute auditory threshold as a measure of strength of excitation, Goldman, Kohn, and Hunt (1983) have shown that this CNS property correlates positively with sensation seeking as measured by Zuckerman's SSS-IV (General scale). Rawlings (1987), applying the "alteration" method for diagnosing mobility of the CNS, and the EPQ for estimating psychoticism, has shown that there exists a strongly expressed negative correlation between the two traits, but only for males. Sales and Throop (1972) have hypothesized a positive correlation between Petrie's reducing-augmenting dimension and strength of the nervous system. Measuring the former dimension by means of the kinesthetic figural aftereffect (KFA) and the latter one on the basis of the slope of RT curve they were able to state that reducers have a stronger CNS as compared with augmenters. This regularity was not found in a study presented by Kohn (1987), where strength of excitation was measured with the slope of RT curves (visual and auditory) and the reducing-augmenting dimension with Vando's RAS inventory (see also Kohn et al., 1987). Also, the relationship between strength of the nervous system and dimensions occurring in Cattell's theory of personality was the subject of interests. Cattell (1972) hypothesized that such traits as assertive ego, general inhibition, hypomanic temperament, exuberance, cortertia, capacity to mobilize versus regression, and exvia versus invia should be linked to strength of the nervous system. Studies conducted by Orlebeke (1972) show, however, that the only dimension among those to be measured by the 16PF that correlates with strength is surgency. In this experiment this CNS property was measured on the basis of the RT max/RT min index. (for explanation see Nebylitsyn, 1972a or Strelau, 1983).

There are no studies in which experimentally measured strength of inhibition

[2]The interchangeable use of the terms personality/temperament is used here because several authors label the same dimensions, depending on the context in which they occur, once as belonging to temperament and once as personality traits. If the latter label is used it has to be assumed that we are dealing with personality characteristics that are first of all biologically determined (see Strelau, 1982, 1987a).

and/or balance between strength of excitation and inhibition (i.e., the remaining CNS properties as measured by the STI) were related to the personality/temperament dimensions presented earlier.

In most of the investigations in which personality/temperament dimensions, conceptualized by psychologists from the West, were compared with the Pavlovian CNS properties, the STI was used for diagnosing these properties.

THE CURRENT STATE OF RESEARCH USING THE STI

In order to present the reader with a full range of data regarding the STI research, this inventory is presented, taking into account the results found in the literature that refer to the item analysis, to the psychometric characteristics of the separate scales, including reliability measures, and to a broad range of validity studies.

Item Analysis

The item analysis of the STI is one of the weakest points of this questionnaire. In its original Polish version the items have been analyzed only for endorsement, and this procedure led to a reduction of items from 150 (first version of STI) to 134 (the actual version). In one of the two studies (Paisey & Mangan, 1980) with the English version of the STI, 33 items were deleted from the 134-item inventory, and in the second study (Stelmack et al., 1985), 23 items. In both studies the criterion for deleting was less than 25% or more than 75% endorsement. There is no information, however, on which of the items did not fulfill the endorsement criterion.

There is probably only one study in which the item-scale correlation of the STI has been analyzed; this is a German version of this questionnaire (Daum & Schugens, 1986). Taking as the lowest value acceptable for future work with the STI a correlation coefficient of .20, the authors stated that 6.8% of the SE items, 9.1% of the SI items, and 34% of the M items have item-scale correlations of less than .20. The high percentage of mobility items not fulfilling the .20 value may be related to the fact that the M scale also comprises items that refer to lability (see p. 189).

Distribution Characteristics

Table 8.1 presents the means and standard deviations of the separate scales obtained in 14 studies, these comprising four mixed groups (males and females), six male samples and four female ones. Among these 14 studies 10 refer to the Polish population, 2 to the West German, and 2 to English-speaking populations.

With respect to strength of excitation, the values vary from 47.11 to 64.41 (median = 54.91) when all of the results (males and females) are taken into

TABLE 8.1
Means and Standard Deviations of the STI Scales

No. References	No. of SS	Sex	Age	Properties of the Nervous System: SE M	SE SD	SI M	SI SD	M M	M SD	B M	B SD
1. Nosal (1974)	100	M,F	19-22(Ugr)	47.11	12.56	55.48	13.2	55.13	11.70	0.89	0.29
2. Terelak (1974)	115	M	20-45(LA)	62.23	12.34	67.65	13.59	60.69	10.07	0.94	0.22
3. Terelak (1974)	95	M	20-45(HA)	64.41	13.02	70.67	11.58	61.22	11.04	0.93	0.21
4. Koscielak (1979)	100	M	25-45 (I)	56.89	12.12	62.50	11.79	57.12	9.42	0.94	0.26
5. Koscielak (1979)	100	M	25-45(NI)	55.53	11.17	58.66	12.57	53.35	10.33	0.97	0.21
6. Klonowicz (1979) (SP)	78	F	Ugr (Moscow)	54.3	13.8			55.5	12.5		
7. Klonowicz (1979) (SP)	78	F	Ugr (Warsaw)	51.0	13.1			59.1	10.5		
8. Strelau (1983)	235	M,F	18-24	49.8	11.8						
	241	M,F	18-24			60.6	11.3				
	242	M,F	18-24					56.0	10.7		
	234	M,F	18-24							0.85	0.30
9. Strelau (1983)	130	M	18-34	57.7	15.92	60.9	15.85	59.4	13.13	0.99	0.39
10. Strelau (1983)	116	F	18-30	48.0	12.94	55.7	15.91	57.1	12.43	0.94	0.40
11. Daum and Schugens (1986)	108	M	23,1 (2,9)	53.9	11.6	59.6	11.9	56.0	8.6		
12. Daum and Schugens (1986)	73	F	23,2 (3,9)	47.3	11.4	56.9	10.4	56.4	9.9		
13. Haase (1986)	22	M,F	18-26(Ugr)	59.1	9.3	55.3	12.3	54.8	8.6		
14. Kohn (1987)	212	M,F	Ugr	104.09(?)	11.19						

M = males
F = females
Ugr = undergraduate students
ST = students
I = inventors
NI = noninventors
LA = low alpha index
HA = high alpha index

account. For males the median is 57.30 (53.9–64.41) and for females Me = 49.50 (47.3–54.30), implying sex differences.

In spite of the equal number of items in both scales, SE and SI, the medians are higher for strength of inhibition as compared with strength of excitation for all three groups of samples. The median for all samples is 59.60 (55.3–70.67), for males Me = 61.70 (55.3–70.67) and in the two female samples the mean values vary from 55.7 to 56.9. As can also be seen, the men in this case score higher than females, but it is not clear whether this difference is significant.

The Mobility scale seems to be less sex specific, relative to the SE and SI scales. The median for all samples is 56.4 (53.35–61.22), whereas for males it is 58.26 (53.35–61.22) and for females, M = 56.4 (55.5–59.1).

As mentioned earlier (see p. 193) the balance of nervous processes is estimated by means of the quotient of SE index divided by the SI index. This quotient was calculated only in 8 studies among the 14 quoted in Table 8.1. The median for all studies is .94 (.85–.99), and exactly the same value for men (with distribution varying from .93–.99) was obtained. In the only female sample the mean (.94) is equal to the median. Thus no sex differences exist in scores of the B scale. All of the values are below 1.00, which suggests that in general strength of inhibition dominates to some degree over strength of excitation.

There are not many studies informing about the distribution of scores of the STI scales, and probably only two of them took place outside Poland (Daum & Schugens, 1986; Vyatkina, 1976). Stawowska (1973, 1977) conducted in Poland a study on 2520 subjects (1255 females and 1265 males) aged 17–60, which yielded normal distributions for all four CNS properties. Similar results were obtained in two other projects (Klonowicz, 1979; Vyatkina, 1976). Also Daum and Schugens (1986), in a study carried out on a German sample comprising 181 subjects (108 men and 74 women) with mean ages 21.1 and 23.2, have shown a similar regularity for the SE and M scales. For the SI scores, a weak negatively skewed tendency occurred. The B scale scores were not taken into account. The results of two independent studies conducted by Strelau (1983) show, however, that the distributions of scores for the SI and B scales do not resemble the normal curve. This was especially evident in females.

Reliability Measures

Reliability of the STI scales was subject to investigation in a number of studies (see Table 8.2). There exists information about the following types of reliability: internal consistency based on the estimation of reliabilities from item parameters, split-half reliability where scores from version A were correlated with scores from version B (see p. 193), and stability measures. The latter are based on retest studies conducted over rather long time intervals.

The only studies that are informative about internal consistency of the STI scales stem from German and English samples. Daum and Schugens (1986) have

TABLE 8.2
Reliability Measures of the STI

No.	References	No. of SS	Sex	Age	SE	SI	M	B	Type of Reliability
1.	Daum and [illegible]jens (1986)	181	M,F	Ugr	.84	.82	.68		IC
2.	Kohn (1987)	212	M,F	Ugr	.81				IC
3.	Kohn et al. (1987)	53	M,F	Ugr	.75				IC
4.	Corulla (1989)*	312	M	17-55	.80	.83	.73		IC
5.	Corulla (1989)*	288	F	16-53	.73	.77	.61		IC
6.	Strelau (1983)	234-242	M,F	18-24	.70	.68	.63	.73	SHR
7.	Carlier (1985)	202	M,F	Ugr	.73	.75	.66		SHR
8.	Daum and [illegible]jens (1986)	181	M,F	Ugr	.89	.83	.76		SHR
9.	Strelau (1983) (6 months interval)	195-241	M,F	18-24	.677	.692	.594	.660	STA
10.	Strelau (1983) (13-15 months interval)	126-136	M,F	18-24	.632	.700	.586	.660	STA

* a yes/no response format was applied

M = males
F = females
Ugr = undergraduate students

IC = internal consistency measured by Cronbach's alpha
SHR = split-half reliability
STA = stability

reported adequate Cronbach's alpha coefficients for the SE and SI scales, whereas the value for the M scale is below .70. Also in Corulla's (1987) study the alpha coefficient is the lowest in case of mobility; this is especially evident among females (.61). For the SE scale, for which internal consistency was measured in five studies, the values vary from .73 to .84, which should be considered satisfactory. The same can be said about the SI scale where the lowest value is .77 and the highest is .84. Probably due to the fact that there do not exist separate items for the B scale, the latter being based on secondary scores (see p. 193), internal consistency of this scale has not yet been estimated.

The split-half reliability measures are generally consistent with the Cronbach's alpha scores. Here again it turns out that mobility shows the lowest values. Among the three coefficients, two are rather unacceptable (.63 & .66). One of those stems from a Polish sample (Strelau, 1983) and the other from a French one (Carlier, 1985). Also not acceptable is one of the three coefficients drawn from the SI scale (an alpha score of .68), obtained in Strelau's study (1983). All of the other scores vary from .70 to .89 and may be regarded as satisfactory or sufficiently high. The only score for the B scale (.73) follows from the fact that, in general, balance of the nervous system was not often the subject for research and this holds true also for all other results presented later.

There exists only scanty information about the stability of the STI scores. The only studies have been conducted by Strelau (1983), one with a 6-month interval and the other one with an interval varying from 13 to 15 months. The results of these two studies are homogeneous. As can be seen from Table 8.2, the coefficients of correlation obtained in these studies for all four scales vary from .59 to .70. Taking into account the rather long time interval, these scores should be regarded as satisfactory. However, they are lower than the split-half and internal consistency measures. Interestingly enough, here again the lowest scores were obtained for the M scale (.59 and .59).

Internal Validity

There exist many data that refer to different aspects of internal as well as external validity of the STI. As regards internal validity, the correlations between the STI scales and factor analytic studies based on the STI items are presented.

Correlations between the STI Scales. The data that are informative about the intercorrelations between the STI scales are presented in Table 8.3, which includes 17 studies. At first glance it is obvious that many significant correlations between the scales are being compared. Most important for us are the comparisons between strength of excitation, strength of inhibition, and mobility.

The SE and SI scales have been correlated in 16 studies. The results are consistent in that they show positive correlations only, varying from .26 to .61 (Me = .42). Taking into account the seven male samples, the median value of

TABLE 8.3
Coefficients of Correlation Between the Properties of the Nervous System

No.	References	No. of Ss	Sex	Age	SE & SI	SE & M	SE & B	SI & M	SI & B	M & M
					Properties of the Nervous System					
1.	Terelak (1974)	115	M	25-45 (LA)	.589a	.595a	.282b	.283b	-.555a	-.266b
2.	Terelak (1974)	95	M	20-45 (HA)	.448a	.713a	.535a	.305b	-.465a	-.385a
3.	Koscielak (1979)	100	M	25-45 (I)	.439	.399	.524	.653	-.483	
4.	Koscielak (1979)	100	M	25-45 (NI)	.568	.536	.250		-.624	-.288
5.	Zarzycka (1980)	59	M	27-49 (NA)	.522a	-.522b	-.579b	.198b	.180c	-.388b
6.	Zarzycka (1980)	59	M	27-49 (A)	.614a	.711b	-.506b	.405b	-.249	-.398b
7.	Strelau (1983)	159	M,F	Ugr	.390b	.597a		.088		
8.	Carlier (1985)	202	M,F	Ugr	.27c	.45c		-.01		
9.	Gilliland (1985)	63	M,F	Ugr	.41c	.51c	.53c	.20	-.53c	.28
10.	Stelmach et al. (1985)*	258	M,F	Ugr 23,7	.44b	.61b		.26		
11.	Daum and Schugens (1986)	181	M,F	23,1 & 23,2	.40a	.51a		.10		
12.	Haase (1986)	22	M,F	18-26 (Ugr)	.33	.60		.01		
13.	Schoenpflug and Muendelein (1976)	72	?	OW	.40b	.52b		.26b		
14.	Przymusinski and Strelau (1986)	211	M,F	17-21		.614				
15.	Barclay (1987)	85	M,F	19-24 (Ugr)	.26c	.539a	.527a	.053	-.616a	.339a
16.	Corulla (1987)	312	M	17-55	.53	.63	.35	.36	-.57	.19
		288	F	16-53	.35	.54	.55	.24	-.55	.27

* a yes/no response format was applied

M = males
F = females
Ugr = undergraduate students
I = inventors
NI = noninventors
OW = office workers
LA = low alpha index
HA = high alpha index
NA = nonaccident engine-drivers
A = accident engine-drivers

a = $p<.001$
b = $p<.01$
c = $p<.05$

the coefficients of correlation increases to Me = .53. There is only one study in which females have been investigated, thus not allowing any conclusions about regularities regarding the interrelations between these CNS properties in females. The same holds true for all of the STI scales to be presented in Table 8.3. It is not easy to answer the question, "In what manner do the positive correlations refer to Pavlov's idea regarding the relationships between the properties under discussion?" If one takes his statement seriously, that excitation (connected with the process of dissimilation) and inhibition (referring to the process of assimilation) are inseparable (Pavlov, 1951–52), then the links between those two properties should not be regarded as unexpected. This relationship is also consistent with Pavlov's assumption, according to which strength of excitation and strength of inhibition should be high in the strong types and low in the weak type.

The positive correlations between strength of excitation and mobility of the nervous processes stated by several Pavlovian typologists (see p. 191) are also evident in the research conducted by means of the STI. In all of the 17 studies, positive correlations were obtained (with the median correlation being .54). The median for the seven male samples is .59. If we consider that searching for novelty and variations in the surroundings has a high stimulating value (see Fiske & Maddi, 1961; Zuckerman, 1979), the lack of orthogonality between these two properties should not be surprising.

The interrelationships between strength of inhibition and mobility of nervous processes based on 15 studies presented in Table 8.3 are considerably consistent also. The, on the average, weak positive relationships between the SI and M scales stated in the studies compared do not seem to be explainable in Pavlov's theory.

Because the balance score is the result of the ratio between the SE and SI values, the correlations between balance of the CNS and strength of excitation, and balance and strength of inhibition, are confounded and thus difficult to interpret. However, we report these correlations because they are presented in the literature.

The results of studies in which the values representing the balance of nervous processes have been compared with all of the three STI scales are rather inconsistent, except for strength of inhibition and balance of the CNS, where 9 of the 10 studies show negative correlations varying from −.25 to −.62 (median = −.54). The median for the male samples decreases to Me = −.48. This regularity can hardly be explained in the light of Pavlov's typology. There do not exist any other empirical data that allow for a reasonable comparison. The correlation coefficients for SE and B scores vary from −.58 to .55 and for M and B scores, from −.40 to .38, thus contradicting any regularities regarding these comparisons.

Factor Analysis of the STI Items. According to our knowledge, there exist four studies in which the items of the STI scales have been factor analyzed. The first was conducted by Paisey and Mangan (1980) on a sample of 277 subjects

(M and F). Taking as the starting point 101 items (33 have been excluded because of the endorsement criterion), the authors obtained 16 oblique factors from which 6 second-order factors emerged. "The first second-order factor combines strength of excitation and mobility; the second obviously reflects a component of strength of inhibition; the third, equally obviously, represents the negative pole of strength of inhibition" (Paisey & Mangan, 1980, p. 127). The three remaining factors did not allow for any reasonable interpretation. It can be stated that the first second-order factor remains the regularity to be found in correlative studies.

Similar results, especially regarding the first two factors, were obtained by Carlier (1985). In her study with 202 subjects (M and F), four orthogonally rotated factors emerged form the analysis of the 134 STI items. F1 is saturated by SE and M items, F2 by SI items, F3 comprises SE items in working situations[3] and F4, ability to adapt to others, that is, mainly mobility items.

Stelmack et al. (1985), using the method of principal components, extracted from 111 STI items 26 factors (23 items were eliminated because they did not fulfill the endorsement criterion). A second-order factor analysis based on results obtained from 258 undergraduate students of both sexes yielded seven factors: F1—Restrain (mainly SI items), F2—Work effort (SE and M items), F3—Flexibility (SE and M items), F4—Emotional control (SI, SE, and M items), F5—Social adaptability. Factors 6 and 7 are regarded by the authors as not interpretable. Factor 1 from this study is the second factor in both former studies and factors F2 and F3 are comparable to the first factors found in Paisey and Mangan's and Carlier's studies. There exist in all of the three scales (SE, SI, M) items that refer to emotional behavior (reactions). It is therefore not surprising that also an emotional factor (F4) showed up.

Six factors were obtained not only by Paisey and Mangan but also in Van Heck's (1987) research, by means of the factor analysis based on principal components. One hundred and sixty-five persons (both sexes almost equally represented) were subjects for the studies. However, and not explicitly stated by the author, the SE items primarily load on the Disturbance (in stress situations) factor. The second factor, Strength of inhibition, is composed of SI items. Strength of excitation in work situations, being a combination of SE and M items, is the third factor. In the fourth factor, Mobility, M items are the most salient ones. The last two factors, Perseverance and Flexibility, are also composed mainly of M items.

No matter what labels are used by the authors of the factor analytic studies in order to identify the extracted factors, it can be concluded that in all of them a separate factor, which comprises SI items, was found. The same holds true for a

[3]In the English as well as in the German translation of the STI the items related to activity, or to human action in general, have been mostly translated as referring to occupational activity, which explains to a given degree the fact that a working-specific SE factor emerged in Carlier's study. The same explanation holds true for the next two studies to be presented in this section.

factor being composed of SE and M items. In the remaining factors, being different in the consecutive studies, no configurations of items have been found that are in contradiction to the regularities presented in correlative studies.

External Validity: STI and other Personality/Temperament Scales

The interrelationships between the CNS properties as measured by the STI and such personality/temperament dimensions as extraversion, neuroticism, psychoticism, anxiety, sensation seeking, and augmenting/reducing are presented, taking into account the correlative studies to be found in the literature as well as factor analytic research comprising those and certain other dimensions. Since there exists only one female sample in which these comparisons have been subject to investigation, the analysis of data does not take into account sex-specific relationships.

STI and Extraversion/Introversion. Since the time Eysenck (1966, 1972) and Gray (1967) put forward the hypothesis that strength of excitation correlates positively with extraversion, there has been a growing interest in studying the relationship between these dimensions. As has been shown in the previous section, the results in which psychometrically diagnosed extraversion was compared with laboratory measures of strength of excitation are contradictory. This cannot be said when both dimensions under discussion are compared on the same level of behavior organization, that is, by means of psychometric tools. The 20 studies presented in Table 8.4 show unequivocally, with only one exception (Stelmack et al., 1985), that extraversion correlates positively with strength of excitation as measured by the STI. The median of the correlation coefficients is Me = .40, with a range from .07 to .60.

Among the 20 studies, comprising 21 samples, 8 were conducted on Polish groups, where extraversion was measured with the MPI. This is the only Eysenckian inventory adapted to the Polish population. The median for these samples is Me = .46, with coefficients varying from .35 to .60. In four studies, where the EPI was used, the median decreases to Me = 34 (.22–.46) and a similar result (Me = .37; .07–.49) was obtained for eight samples in which extraversion was diagnosed by means of the EPQ (including the revised form). On the basis of these results it can be concluded that the fact that, in the Extraversion scale, impulsivity items are included (EPI) or excluded (EPQ) does not essentially influence the relationship between strength of excitation and extraversion. The lack of correlation stated in the study conducted by Stelmack et al. (1985) can be explained partially be the fact that instead of a 3-point rating scale, the authors used a yes/no scale. Further, they deleted 23 items from the correlative analysis because of the endorsement criterion. The endorsement criterion problem also holds true for Paisey and Mangan's (1982) study, which

TABLE 8.4

Coefficients of Correlation Between Extraversion and Properties of the Nervous System

No.	References	No. of Ss	Sex	Age	SE	SI	M	B	Inventory
					Properties of the Nervous System				
1.	Strelau (1969)	78	M,F	Ugr	.449a	.007	.667a		MPI
2.	Strelau (1970)	159	M,F	Ugr	.476a	.028	.652a		MPI
3.	Strelau (1971)*	171	M,F	Ugr	.444a				MPI
		183	M,F	Ugr		.08			MPI
		178	M,F	Ugr			.694a		MPI
		199	M,F	Ugr				.350a	MPI
4.	Terelak (1974)	115	M	20-45 (LA)	.381a	.052	.563a	.356a	MPI
5.	Terelak (1974)	95	M	20-45 (HA)	.597a	.266	.730a	.313a	MPI
6.	Ciosek and Oszmianczuk (1974)	70	M	?	.349b	.165	.517a		MPI
7.	Zarzycka (1980)*	59	M	27-49 (NA)	.504a	.160	.536a	-.413c	MPI
8.	Zarzycka (1980)*	59	M	27-49 (A)	.548a	.156	.448a	-.504a	MPI
9.	Carlier (1985)	202	M,F	Ugr	.38c	-.21c	.54c		EPI
10.	Gilliland (1985)	63	M,F	Ugr	.22	-.16	.35c	.36c	EPI
11.	Kohn (1987)	212	M,F	Ugr	.30b				EPI
12.	Kohn et al. (1987)	53	M,F	Ugr	.46b				EPI
13.	Paisey and Mangan (1982)	174	?	?	.37	-.07			EPQ
14.	Gilliland (1985)	63	M,F	Ugr	.42c	.32c	.19	.12	EPQ
15.	Stelmack et al. (1985)**	258	M,F	Ugr 23, 7	.07	-.09	.15		EPQ
16.	Daum and Schugens (1986)	108	M,F	Ugr	.42a	-.14	.63a		EPQ
17.	Larsen and Baggs (1986)	40	M,F	Ugr	.20	-.14	.44b	.23	EPQ
18.	Richards (1986)*	79	M,F	17-39	.49a	.03	.59a		EPQ
19.	Daum et al. (1988)	59	M	Ugr (20-32)	.40b	-.22	.59a		EPQ
20.	Corulla (1989)**	312	M	17-55	.18	-.05	.27	.19	EPQ-R
		288	F	16-53	.31	.02	.30	.23	EPQ-R

*data published in Strelau (1983)
**a yes/no response format was applied

M = males
F = females
Ugr = undergraduate students

LA = low alpha index
HA = high alpha index
NA = nonaccident engine drivers
A = accident engine-drivers

a = $p < .001$
b = $p < .01$
c = $p < .05$

deleted 33 items for the same reason. In spite of that, the correlation between extraversion and strength of excitation was still positive (.37).

The second CNS property to which considerable attention has been paid in studies of extraversion is mobility. As can be seen from Table 8.4, the results reflecting the relationship between the two traits under discussion are unequivocal and they confirm the hypothesis that there is a positive correlation between extraversion and mobility of the CNS. The median of the coefficients of correlation obtained from 18 studies is rather high (Me = .54; .15–.73) and extends the median for strength of excitation to .46. These data, again, are not in accordance with the experimental studies that suggest a lack of correlation between these two variables. If we consider the results separately for the eight Polish samples (with MPI applied) and for those obtained by means of EPI and EPQ, then we can see that the coefficients of correlation are the highest for MPI (Me = .67; .45–.73) and the lowest for EPQ (Me = .37; .15–.63) where also eight samples were investigated. There are only two results for the EPI (.35 and .54), and they are situated within the range of the EPQ-M coefficients.

The two remaining CNS properties, strength of inhibition and balance of nervous processes, have not been related in the non-STI studies to extraversion, and this holds true also for studies where other personality/temperament dimensions were related to the CNS properties. Not going into the details, one has to state that strength of inhibition as diagnosed by means of the STI does not correlate, in general, with extraversion (Me = .02, with distributions from −.22 to .32). Among the 19 studies, the coefficients attained a value >.17 in four samples. In case of balance of the CNS there are only 8 studies in which this property of the CNS was compared with extraversion. The results are not univocal. In two samples (Zarzycka, 1980) the coefficients of correlation are negative and significant, whereas in 6 studies they are positive, but not extending the value of .36. The main trend (Me = .27) suggests a low positive correlation between extraversion and balance of the CNS.

STI and Neuroticism. The relationship between strength of excitation and neuroticism predicted by Eysenck (1947) some decades ago has been proven in psychometric research. Table 8.5 displays 20 studies that show a negative correlation between those dimensions (Me = −.46, with distribution from −.13 to −.56).

Among the 20 samples there are 8 where the MPI was applied, that is, the Polish studies (Me = −.46; −.38 to −.56). In three samples the EPI (Me = −.49; −39 to −.54) was used, and in nine the EPQ (Me = −.48; −.13 to −.56). The coefficients of correlation do not essentially differ as a function of the kind of inventory used to diagnose neuroticism. The unanimous relationship between strength of excitation and neuroticism, observed in psychometric studies, does not correspond with the experimental data, where contradictory results exist.

As shown in the previous section, neuroticism and mobility do not seem to be

TABLE 8.5
Coefficients of Correlation Between Neuroticism and Properties of the Nervous System

No.	References	No. of Ss	Sex	Age	Properties of the Nervous System SE	SI	M	B	Inventory
1.	Strelau (1969)	78	M,F	Ugr	-.478a	-.450a	-.300c		MPI
2.	Strelau (1970)	159	M,F	Ugr	-.557a	-.526a	-.215c		MPI
3.	Strelau (1971)*	169	M,F	Ugr	-.378a				MPI
		178	M,F	Ugr		-.246b			MPI
		177	M,F	Ugr			-.174		MPI
		197	M,F	Ugr				-.08a	MPI
4.	Terelak (1974)	115	M	20-45 (LA)	-.538a	-.588a	-.209c	-.108	MPI
5.	Terelak (1974)	95	M	20-45 (HA)	-.444a	-.331b	-.349a	-.152a	MPI
6.	Ciosek & Oszmianczuk (1974)	70	M	?	-.504a	-.396b	-.296c		MPI
7.	Zarzycka (1980)*	59	M	27-49 (NA)	-.442a	-.496a	-.141	-.112	MPI
8.	Zarzycka (1980)*	59	M	27-49 (A)	-.426b	-.545b	-.173	-.020	MPI
9.	Carlier (1985)	202	M,F	Ugr	-.49c	-.48c	-.21c		EPI
10.	Gilliland (1985)	63	M,F	Ugr	-.39c	-.02	-.23	-.33c	EPI
11.	Kohn (1987)	212	M,F	Ugr	-.54b				EPI
12.	Paisey & Mangan (1982)	174	?	?	-.53	-.14			EPQ
13.	Gilliland (1985)	63	M,F	Ugr	-.36c	-.29	-.24	-.08	EPQ
14.	Stelmack et al. (1985)**	258	M,F	Ugr 23, 7	-.13	-.12	-.07		EPQ
15.	Daum & Schugens (1986)	108	M,F	Ugr	-.51b	-.25b	-.24c		EPQ
16.	Larsen & Baggs (1986)	40	M,F	Ugr	-.56b	-.41b	-.33c	-.02	EPQ
17.	Richards (1986)**	79	M,F	17-39	-.50a	-.40a	-.33b		EPQ
18.	Daum et al. (1988)	59	M	Ugr(20-32)	-.48a	-.38b	-.34b		EPQ
19.	Corulla (1989)**	312	M	17-55	-.24	-.26	-.10	.07	EPQ-R
		288	F	16-53	-.16	-.15	-.01	.00	EPQ-R

* data published in Strelau (1983)
**a yes/no response format was applied

M = males
F = females
Ugr = undergraduate students
LA = low alpha index
HA = high alpha index
NA = nonaccident engine-drivers
A = accident engine-drivers

a = $p < .001$
b = $p < .01$
c = $p < .05$

correlated with each other when mobility was diagnosed in experimental settings. The data presented in Table 8.5 contradict this statement partially in that they show a clear-cut tendency for a negative, though not high, correlation between both dimensions under discussion. The median for the 18 studies in which these dimensions were related to each other is Me = −.22 (with a range from −.01 to −.35). When the different measures of neuroticism (MPI, EPI, and EPQ) are taken into account, the mean value in fact does not change. For the MPI samples the median is −.21 (−.14 to −.35), for EPQ, Me = −.24 (varies from −.01 to −.34), and the two coefficients of correlation for EPI are −.21 and −.23.

As regards the two remaining CNS properties, strength of inhibition is negatively correlated with neuroticism (Me = −.38; with a range from −.02 to −.59), whereas balance of the nervous processes does not correlate with this temperament dimension (Me = −.08; −.33 to −.7). Among the 10 scores representing the "balance-neuroticism" relationship, there is only one coefficient of correlation (−.33) which extends the value of −.15.

STI and Anxiety. Links between anxiety and the type of nervous system have been suggested by Pavlov and some of his followers. The weak type is supposed to have a higher level of anxiety as compared with the strong type of CNS. As mentioned in the previous section, this regularity came out in animal research (Kolesnikov, 1953; Krushinsky, 1947), and theoretical arguments for this relationship may be found in several publications (Marton & Urban, 1966; Nebylitsyn, 1959; Strelau, 1969, 1983).

Nine of the psychometric studies aimed at examining the relationships between the CNS properties and anxiety have been conducted on Polish samples, where the MAS and the STAI inventories were used as measures of anxiety. Only four studies have been found by the authors that present results obtained outside of Poland, mainly on German samples. In these studies the STAI was used to diagnose anxiety. The only exception is Carlier's (1985) French project in which the Cattell Anxiety Scale was applied. As may be shown from Table 8.6, the kind of inventory by means of which anxiety was measured does not have much influence on the value and sign of the coefficients of correlation. This allows us to present the regularities expressed in Table 8.6 without taking into account the specific anxiety measures.

The results for the SE scale correspond fully with the regularity found in animal research. In all 13 studies anxiety correlates negatively with strength of excitation. The median (Me = −.58) suggests that the correlation is rather high. In all of the studies in which the coefficients vary from −.39 to −.72, the above stated relationship is statistically significant.

Also, negative correlations, however of lower value, were obtained when anxiety scores were compared with scores from the M scale. Among the 11 studies, 10 negative coefficients came out, varying from −.18 to −.60. The

TABLE 8.6
Coefficients of Correlation Between Anxiety and Properties of the Nervous System

No.	References	No. of Ss	Sex	Age	SE	SI	M	B	Inventory
1.	Strelau (1969)	75	M,F	Ugr	-.595a	-.412a			MAS
2.	Strelau (1971)**	148	M,F	Ugr	-.481a				MAS
		159	M,F	Ugr		-.202c			MAS
		157	M,F	Ugr			-.177		MAS
		200	M,F	Ugr				-.190c	MAS
3.	Strelau (1973)**	159	M,F	Ugr	-.554a	.359a	.289b		MAS
4.	Terelak (1974)	115	M	20-45 (LA)	-.617a	-.581a	-.282b	.002	MAS
5.	Terelak (1974)	95	M	20-45 (HA)	-.505a	-.477a	-.345a	-.063	MAS
6.	Sosnowski and Wrzesniewski (1986)	48	M	19-24	-.63a	-.45b	-.41b		MAS
7.	Sosnowski and Wrzesniewski (1986)	48	M	19-24	-.72a	-.52a	-.60a		STAI
8.	Zarzycka (1980)	59	M	27-49 (NA)	-.467a	-.489a	-.226c	-.226c	STAI
9.	Zarzycka (1980)	59	M	27-49 (A)	-.394a	-.332c	-.224	.140	STAI
10.	Muendelein (1982)	126	M,F	18-55	-.57a				STAI
11.	Schoenpflug & Muendelein (1986)	72	M,F	OW	-.64b	-.34b	-.22c	.36c	STAI
12.	Daum et al. (1988)	59	M	Ugr(20-32)	-.62a	-.29c	-.42b		STAI
13.	Carlier (1985)	202	M,F	Ugr	-.58c	-.59c	-.25c		CAS*

* Catell Anxiety Scale
** data published in Strelau (1983)

M = males
F = females
Ugr = undergraduate students
OW = office workers
LA = low alpha index
HA = high alpha index
NA = nonaccident engine-drivers
A = accident engine-drivers

a = $p < .001$
b = $p < .01$
c = $p < .05$

median for all 11 studies is Me = −.25. The only positive coefficient of correlation (.29) occurs, for unexplained reasons, in Strelau's (1983) study. The fact that strength of excitation correlates positively with mobility of the CNS elucidates, to some degree, the negative correlation between mobility and anxiety.

With one exception (Strelau, 1983) all of the 12 studies give support for a moderate negative correlation between anxiety and strength of inhibition (Me = −.43). As regards the relationship between balance of the nervous system and anxiety, the results obtained from 6 studies are contradictory (Me = −.03, with distribution of correlations varying from −.23 to .36), thus not allowing any reasonable conclusion.

STI and Psychoticism. The fact that Eysenck and Eysenck (1975) have developed an inventory that includes not only extraversion-introversion and neuroticism (as was the case with the former Eysenckian inventories) but also psychoticism, has given us an opportunity to search for links between this personality/temperament trait and the CNS properties. Some general hypotheses that psychoticism should be related to nervous system types as understood by Pavlov have been put forward by Claridge (1985, 1987). However, the kind of relationship between these two concepts has not been specified by him. It has to be stated that psychoticism was seldom compared with the Pavlovian concepts.

If we consider that psychoticism as measured by the EPQ has much in common with impulsivity and with "impulse control" (Eysenck, 1970; Eysenck & Eysenck, 1985), then one may predict that this dimension should be related to strength of inhibition and to balance of the CNS as defined by Pavlov and operationalized in the STI. High level of psychoticism (i.e., high impulsivity and low "impulse control") should correlate negatively with strength of inhibition and positively with balance of nervous processes. The positive correlation of the latter property is explained by the fact that the higher the scores indicating the balance of nervous processes, the larger the dominance of excitation over inhibition.

We were able to locate 8 studies in which the EPQ psychoticism scale was related to CNS properties measured by means of the STI. They are presented in Table 8.7. The table does not include Polish data, given that the EPQ is not used in Poland. This is caused by difficulties in adapting the psychoticism scale to the Polish population.

If we take into account the SE scale, it is easy to observe that strength of excitation does not correlate with psychoticism (Me = −.02; with coefficients varying from −.26 to .16). The same holds true for the mobility scores, where the median of the correlations between psychoticism and mobility, derived from eight samples, is Me = −.04 (from −.18 to .11). Because Rawlings (1987) has stated in his study a high negative correlation between psychoticism and experimentally measured mobility (but only for men), let us have a look at the two male samples. Daum, Hehl, and Schugens (1988) obtained a zero correlation (.06)

TABLE 8.7
Coefficients of Correlation Between Psychoticism and Properties of the Nervous System

No.	Rererences	No. of Ss	Sex	Age	Properties of the Nervous System SE	SI	M	B	Inventory
1.	Paisey and Mangan (1982)	174	?	?	-.14	-.54			EPQ
2.	Gilliland (1985)	63	M,F	Ugr	.12	-.03	.13	.16	EPQ
3.	Stelmach et al. (1985)*	258	M,F	Ugr 23,7	-.02	-.12	-.03		EPQ
4.	Daum and Schugens (1986)	108	M,F	Ugr	.04	-.40a	-.03		EPQ
5.	Larsen and Baggs (1986)	40	M,F	Ugr	.16	-.27c	.11	.53b	EPQ
6.	Richards(1986)*	79	M,F	17-39	-.09	-.43a	-.02		EPQ
7.	Daum et al. (1988)	59	M	Ugr(20-32)	.00	-.24	-.06		EPQ
8.	Corulla (1989)*	312	M	17-55	-.26	-.37	-.18	.11	EPQ-R
		288	F	16-53	-.15	-.25	-.10	.06	EPQ-R

* a yes/no response format was applied

M = males
F = females
Ugr = undergraduate students
LA = low alpha index
HA = high alpha index

a = $p < .001$
b = $p < .01$
c = $p < .05$

between these two dimensions, whereas in Corulla's large sample (312 men) a low negative, but statistically significant correlation (−.18) was obtained, thus partially supporting Rawlings data.

As hypothesized, the correlation between strength of inhibition and psychoticism is negative (Me = −.27). All coefficients of correlation have a minus sign (−.03 to −.54). However, in two studies (Gilliland, 1985; Stelmack et al., 1985) the scores should be interpreted as a lack of correlation (−.03 and −.12). There exist only four projects in which balance of the CNS was compared with psychoticism. The results are not very consistent. Whereas the coefficient of correlation derived from Larsen and Baggs' (1986) data confirms the previously presented hypothesis (.53), this cannot be said in the case of the three remaining samples where the positive correlation varies from .06 to .16 and is statistically not significant.

STI and Sensation Seeking. As known to the authors, the hypothesis put forward by Zuckerman (1979) that there exist links between the Pavlovian types of the CNS and sensation seeking has been subject to investigation in five psychometric studies with respect to strength of excitation. The number of studies decreases to four when strength of inhibition and mobility are related to this personality/temperament trait, and to three, when balance of the CNS is compared with sensation seeking. In the studies mentioned above and presented in Table 8.8, the SSS-IV or the SSS-V forms were used as measures of this trait.

The SE scores, when related to sensation seeking, seem to be positively correlated with the TO (Me = .21) and TAS (Me = .27) scales. The medians of the three remaining scales indicate a zero correlation between strength of excitation and sensation seeking. Thus the experimentally stated positive correlation between the two dimensions under discussion (Goldman et al., 1983) has been proved in psychometric studies only partially.

When the remaining CNS properties are considered, only some results are mentioned here. Strength of inhibition seems to correlate negatively, however low, with four of the SSS scales. In three from the four studies the TO, ES, Dis and BS scales correlate with the SI scores in the range from −.17 to −.34. In the case of mobility of the CNS, if significant correlations between this property and sensation seeking occur, all of them have a positive sign, and this is true for all SSS scales. Except for one coefficient of correlation with a minus sign and indicating a zero correlation (−.03 for ES), all of the 20 coefficients related to mobility are positive and vary from .04 to .63. The highest single scores were obtained for TO (.63), TAS (.51), Dis (.48) and for BS (.47). The SSS scores, when compared in three studies with balance of the CNS, show a tendency to correlate positively and this holds true for all five SSS scales. Among the 15 coefficients of correlation in which balance was related to sensation seeking, there are eight scores, varying from .20 to .31, which support the earlier mentioned tendency.

TABLE 8.8
Coefficients of Correlation Between Sensation Seeking and Properties of the Nervous System

No.	SE					SI					M					B				
	TO	TAS	ES	DIS	BS	TO	TAS	ES	DIS	BS	TO	TAS	ES	DIS	BS	TO	TAS	ES	DIS	BS
1.	.25b	.36a	.08	.01	.25b															
2.	.21	.33c	.28c	.00	-.01	.11	.30c	.18	-.09	.00	.26	.34c	.31c	.06	.16	.11	.06	.11	.10	-.03
3.	.28c	.27c	.12	.17	.31c	-.26	-.12	-.29c	-.33c	-.25	.63a	.51a	.32c	.48a	.47a					
4.	-.07	.12	-.17	-.12	-.03	-.29	-.01	-.17	-.34	-.27	.12	.18	-.03	.04	.11	.23	.11	.02	.26	.25
5.	.15	.24	.05	.04	.07	-.21	-.01	-.19	-.18	-.22	.23	.18	.15	.16	.14	.31	.20	.23	.20	.23

1. Oleszkiewicz-Zsurzs, 1984; SSS-IV; 171 males (16-20 years)
2. Gilliland, 1985; SSS-V; 58 males and females (undergraduates)
3. Daum et al., 1988; SSS-IV; 59 males (20-32 years)
4. Corulla, 1989; SSS-V; 312 males (17-55 years)
5. Corulla, 1989; SSS-V; 288 females (16-53 years)

STI and Reducing/Augmenting and Reactivity. To finish the review of research in which the STI has been compared with other personality/temperament dimensions, two studies have to be mentioned in which Kohn (1987) and coworkers (Kohn et al., 1987) have searched for links between strength of excitation as measured by the STI and the augmenting/reducing dimension, diagnosed by means of the Vando's Reducer-Augmenter Scale (RAS). As predicted, the coefficients of correlation were positive in both studies (Kohn, 1987—.29, $p < .01$; Kohn et al. 1987—.48, $p < .01$). This means that individuals with a strong nervous system are reducers, whereas augmenters tend to have a weak nervous system. The theoretical considerations justifying this relationship have been presented in several studies (see Kohn, 1987; Kohn et al., 1987; Strelau, 1982, 1987b).

In the two studies just mentioned, the SE scale was also related to psychometrically measured reactivity. The latter was estimated by means of the Reactivity Scale developed by Kohn and aimed at measuring reactivity as understood in Strelau's (1983) regulative theory of temperament. In two studies (212 subjects in one study and 53 in the other one) the same coefficient of correlation was obtained (−.45, <.01) (Kohn, 1987; Kohn et al., 1987). A negative correlation stated in these projects is in accordance with the theory, which says that high scores on the strength of excitation dimension are indicators of low level of reactivity (see Strelau, 1983).

External Validity: Studies Based on Factor Analyses

There exist at least eight studies in which the STI scales were factor analyzed together with other temperament/personality scales. The first one was conducted by Terelak (1974; Strelau & Terelak, 1974) on two pilot samples (95 and 115 men aged from 20 to 45) differing in scores of the EEG alpha index. The STI scales have been factor analyzed together with the MAS, MPI, Guilford-Zimmerman Temperament Survey (GZTS), and the Thurstone Temperament Schedule (TTS) scales. The study comprised 24 traits altogether. By means of the principal components method, in one of the groups six and in the other one seven factors have been extracted. The structure of factors is similar, thus we are limiting the description to the six factors to be separated in the high alpha index pilot group: F1 (Vigorousness or Energeticness) comprises such traits as extraversion, strength of excitation, mobility, ascendance, sociability, impulsive, dominant, and sociable[4]; F2 (Emotionality) includes such traits as manifest anxiety, neuroticism, strength of excitation, strength of inhibition, emotional stability and emotional stable, the latter four dimensions with negative signs; F3 (Thoughtfulness) has the highest loadings in the restraint, thoughtfulness, and

[4]The denominations of traits for the separate factors have been given in accordance with the names used by the respective authors themselves.

reflective scales; F4 (Sociability) comprises personal relations, objectivity, and friendliness; F5 (Equilibrium of nervous processes) has the highest loading in the B scale; F6 (Masculinity) includes the masculinity trait only.

The structure of the first two factors corresponds to the correlational data presented in the former section. Factor 1 loads, among other things, on extraversion, strength of excitation, and mobility, and these traits correlate positively with each other, as shown in Table 8.4. In Factor 2 neuroticism and anxiety go together with weak excitatory and weak inhibitory processes. A negative correlation between anxiety and neuroticism, on the one hand, and strength of excitation and strength of inhibition, on the other hand, has been found in correlational studies (see Tables 8.5 and 8.6).

Van Heck (1987) has factor analyzed the scores representing 31 traits as measured by several inventories. Among them were the STI and the GZTS scales. The STI items have been subject to factor analysis prior to the analysis comprising all the temperament/personality dimensions being researched. On the basis of this analysis, six first-order STI factors were separated and those were taken as a starting point for further factorial procedures, thus making impossible any comparison with other studies, where the STI scales were factor analyzed with other temperament scales.

The number of factors as well as their specific structure in which the STI scales occur together with other temperament scales changes from study to study. Curiously enough, in five studies, in which the Eysenckian extraversion and neuroticism dimensions were factor analyzed together with the STI scales, three of the studies (Daum et al., 1988; Paisey & Mangan, 1980; Richards, 1986) show consistently that extraversion composes one factor, together with strength of excitation and mobility of nervous processes, as has been shown in Terelak's project. These data, again, are consistent with correlational studies. There are, however, two studies conducted by Stelmack et al. (1985) and Corulla (1989) that show that strength of excitation, mobility, and strength of inhibition make up one factor that is not saturated with extraversion.

Contradictory results were obtained in studies where, among other scales, the sensation seeking traits were factor analyzed together with the CNS properties. In two investigations (Corulla, 1989; Paisey & Mangan, 1980) nervous system properties and the sensation seeking scales constitute separate factors, whereas two other studies show that sensation seeking constitutes one factor together with strength and excitation (Van Heck, 1987) or with strength of excitation and mobility of the CNS (Daum et al., 1988).

In two of the four studies (Daum et al., 1988; Richards, 1986) psychoticism, diagnosed by means of the EPQ, composes one factor together with strength of inhibition. This regularity does not occur in Paisey and Mangan's (1980) and in Corulla's (1989) studies, where both dimensions under discussion fall into separate factors.

In one of the factorial projects (Barclay, 1987) the STI scales were the subject of the research together with the 16PF scales.[5] However, the Cattellian personality factors are not in the core of our interests, but it is worthwhile to note that some interesting regularities came out of this study. Results obtained from 85 males aged 19 to 24 years allowed the author to separate the following four factors: F1 (Emotional stability): Strength of excitation and the C, Q3, L, Q4, and O scales from the 16PF inventory; F2 (Tough mindedness): Mobility and A, F, H, E, and Q2; F3 (Activity): Strength of excitation, Mobility, Balance, and H, F, Q1, E, and N; F4 (Driven compulsion): Balance, Strength of inhibition, Q4, and E.

Barclay's study suggests that the range of interrelationships between the Pavlovian CNS properties and the personality factors as separated by Cattell is much broader than suggested by Orlebeke (1972). On the basis of his experimental data Orlebeke was able to show that the only factor to be related to strength of excitation is surgency (see p. 196). However, before any reasonable conclusion can be made, research based on factor analytic studies comprising the STI and the 16PF scales calls for replication.

In general, one has to state that the factor analytic studies comprising scores from the STI and the inventory scales under discussion are much less unequivocal regarding the relationships between the Pavlovian CNS properties and other temperament/personality dimensions, as was the case in correlational studies presented in the previous section.

External Validity: Laboratory and Field Studies

Among the four Pavlovian CNS properties as measured by the STI, it was strength of excitation to which almost exclusively attention was paid when examining the construct validity of the STI scales. This holds true for studies in which experimental settings were used or for which the correspondence of STI data with laboratory indices of the CNS properties was analyzed. There is no place to refer to the dozens of studies in which the Strength of Excitation scale was used for this purpose,[6] thus we will limit our description to some general statements having support in experimental data.

In most of the studies where the scores of the SE scale were compared with laboratory indices of this CNS property, such as the Slope of RT Curve (Beauvale & Placzynta, 1986; Carlier, 1985; Daum et al., 1988; Kohn, 1987) or Extinction with Reinforcement (Gilliland, 1985), a lack of correlation between

[5]Also, four scales of adjective ratings from the Barclay Classroom Assessment System were factor analyzed. For clarity they are omitted in our discussion.

[6]For a detailed description see Eliasz (1985a, 1985b, 1987), Friedensberg (1985), Klonowicz (1974, 1985, 1987), Muendelein (1982), and Strelau (1983, 1984).

the relevant variables was found. This negative result between inventory data and experimental indices of strength of the CNS cannot, however, be regarded as evidence for lack of validity of the SE scale. The reason for this conclusion consists in the fact that laboratory studies aimed at diagnosing the Pavlovian CNS properties show that the estimation of these traits is highly dependent on the type of stimuli, kind of reaction, and sort of CNS trait indicator used in experimental settings (see Kohn et al., 1987; Nebylitsyn, 1972b; Strelau, 1965a, 1972b, 1983).

Field studies as well as experimental settings in which individuals, varying in strength of excitation (as measured by the SE scale), were confronted with behaviors and situations differing first of all in their stimulative value show some regularities.

In situations under stress consisting of performing activities of high stimulative value or of situations that are regarded as highly stimulating, the performance of individuals differs depending on the strength of the nervous system. Individuals with a weak nervous system perform usually lower as compared with individuals characterized by a strong nervous system (see e.g., Halmiova & Sebova, 1986; Klonowicz, 1985; Schulz, 1986; Strelau, 1983).

In the solution of operational tasks or in decision-making situations, "strong" individuals prefer risk taking over risk avoiding, whereas in "weak" individuals a reverse relationship dominates, that is, risk avoidance is preferred over risk taking (see Kozlowski, 1977; Przymusinski & Strelau, 1986; Strykowska, 1978).

Individuals who perform professional activity of high stimulating value (e.g., pilots, steel-workers, locomotive engineers) have, on the average, higher scores on the SE scale as compared with the sample representing the Polish population (Strelau, 1983).

In order to avoid the state of stress, individuals differing in strength of excitation use different styles of action to cope with stressors. The "weak" individuals perform, as compared with the "strong" ones, significantly more auxiliary activities, which consist in orienting, preparatory, corrective, controlling and protective activities (see e.g., Friedensberg, 1985; Muendelein, 1982; Schoenpflug & Muendelein, 1986; Strelau, 1983). The auxiliary actions, by safeguarding, facilitating, and/or simplifying the performance, lower the stimulative value of activity or situation in which the activity is performed.

When the psychophysiological costs of performance under stress are considered, it has been stated in several experiments (Klonowicz, 1974, 1985, 1986) that the "weaks" pay more costs in situations of high stimulative value, as compared with normal situations. In situations of deprivation such a relationship occurs in individuals with the strong nervous system, that is, in such situations they pay more psychophysiological costs as compared with normal situations.

The results, which support the earlier stated regularities, are relatively consistent in that they show from study to study similar regularities. This suggests that the STI, at least when the SE scale is considered, seems to have some predictive value as regards the relationship between behaviors and strength of excitation when behavior and/or situations are considered from the point of view of their stimulative value.

STUDIES ON THE STI CONDUCTED ON GERMAN SAMPLES

In this section, we report empirical studies conducted with the STI on German samples. These empirical studies differ to some degree from those reviewed until now. First, the analysis of data has been done separately for males and females; second, the age distribution of our samples is much broader as compared to the published studies; and third, much attention has been paid to the item statistics as well as to the validity characteristics of the scales. The STI scales have been correlated with the Eysenckian and with the sensation seeking scales, and also with the Personality Research Form (PRF). The PRF has not yet been used in studies dealing with the STI.

Method and Procedure

Subjects. Four samples, including altogether 883 subjects, were used in our studies. For gender distribution and details regarding age characteristics for all samples see Table 8.12. The largest sample, Bielefeld 1 (B1), was recruited by means of announcements in local newspapers. Test materials were sent and received by mail. This sample, consisting of 428 males and females, covers an age range from 15 to 80 years. Sixty percent of the females and 71% of the males were at least high-school graduates.

The recruiting of the remaining three samples was done in a homogeneous manner, but different from sample B1. For course requirements, psychology students had to test two to five acquaintances with different inventories and tests, including the STI. The Bielefeld 2 (B2) sample consisted of 189 subjects of both sexes. Their age range, varying from 17 to 47, was somewhat more restricted as compared with the other samples. This sample was recruited by students taking a 1987 summer course in personality testing at the University of Bielefeld. The same recruitment method was used for the Bielefeld 3 (B3) sample by students taking a similar course in the 1987 winter semester. This sample included 173 males and females, aged from 16 to 66.

For replicational purposes, a fourth sample, consisting of 131 subjects of both sexes in the age range from 17 to 65 years, was studied in Duesseldorf (D). The recruitment procedure was comparable with samples B2 and B3.

For studying the external validity of the STI scales, different inventories in the separate samples were used. Subjects who answered the PRF were given feedback regarding their PRF personality profile.

Measures. Seven different inventories were used in our studies. Their description follows.

The STI was used in the German version translated by K. H. Meyer (Institute of Psychology, Leipzig).

For measures within the framework of the personality theory as developed by Eysenck, the following instruments were used: (1) the Eysenck Personality Questionnaire (EPQ) in the German adaptation by Ruch (1988), used in samples B1 and D; (2) the Eysenck Personality Inventory (EPI)-Form A, used in samples D and B3, and Form B (sample D), in the German version prepared by Eggert (1974); (3) corresponding scales from the revised version of the Freiburger Persoenlichkeitsinventar (FPI-R) developed by Fahrenberg, Hampel, and Selg (1984), applied in sample B2.

For measuring the sensation seeking dimensions, the SSS Form 4 in the German adaptation by Unterweger (1980) was used in the D sample. The SSS Form 5, as adapted by Andresen (1986), was applied in sample B2.

The Personality Research Form (PRF), as constructed by Jackson (1967), and based on the concept of needs developed by Murray (1938), was used in sample B1. Stumpf, Angleitner, Wieck, Jackson, and Beloch-Till (1985) are the authors of the German version of the PRF.

Results and Comments

Characteristics of the Scales. The means and the standard deviations of the STI scales are given in Table 8.9. As regards the SE scale, the means for males vary from 48.7 to 56.7, whereas for women, from 49.0 to 52.4. The SI scale shows variations for males in the realm of 60.6 to 62.9, and for females in the range of 56.1 to 57.6. The means for the M scale oscillate for males between 51.6 and 58.1, and for females between 56.1 and 59.8. The fluctuation of the means of the B scale is .83 to .99 for males, and .88 to .99 for females.

The means are comparable with those presented in the literature (see Table 8.1). We would also like to draw attention to the gender differences. For the three Bielefeld samples, a multivariate analysis of variance of the scales by the factors sample and sex showed significant sex differences in all scales except the B scale.[7] Considering the SE and SI scales, men scored higher than women. In the case of the M scale, the pattern was reversed.

[7]The tables for the analysis of variance may be obtained by writing to the authors.

TABLE 8.9

Means and Standard Deviations of the STI-Scales

				SE		SI		M		B	
Studies	N	Sex	Age	M	SD	M	SD	M	SD	M	SD
Bielefeld 1 (Announcement)	184	M	15-18 x=33, SD=13.5	56.71	11.96	60.57	13.17	56.25	11.22	.99	.37
	244	F	16-18 x=33, SD=13.2	51.73	11.14	57.62	11.80	56.88	10.69	.95	.35
Bielefeld 2 (Student-course SS 87)	95	M	17-42 x=27, SD=5.7	48.70	10.44	60.35	9.41	51.55	11.89	.83	.20
	94	F	19-47 x=27, SD=6.2	50.74	9.50	56.97	10.64	59.14	12.91	.92	.23
Duesseldorf (Student-course SS 87)	63	M	18-63 x=32, SD=12	55.19	11.03	62.89	12.44	53.64	10.26	.91	.29
	75	F	17-65 x=31, SD=11.4	52.40	11.42	56.44	13.20	59.80	8.98	.99	.33
Bielefeld 3 (Student-course WS 87)	37	M	16-58 x=27, SD=8	52.60	13.36	56.57	12.14	58.91	11.06	.96	.28
	100	F	18-66 x=26, SD=8	49.03	11.05	56.10	11.53	56.17	10.59	.88	.27

x = mean age
SD = standard deviation

Reliability. The reliability score of the B scale was calculated by means of the correlations of the balance measures between Form A and Form B of the STI items (see p. 193), that is, the split-half reliability was measured. Except for the B scores, the Cronbach-Alpha coefficient was used. The results are presented in Table 8.10.

The medians of the Cronbach-Alpha coefficients are .81 for the SE scale, .83 for the SI scale, and .76 for the mobility scale. The balance measure shows a median of .78. These values are also comparable to those reported in earlier studies (see Table 8.2). In general, the reliability estimates may be regarded as satisfactory. However, it has to be kept in mind that the scales sample quite a large number of items (44 to 46), somewhat unusual for advanced personality scales.

Item Statistics. In spite of the rather high reliability values, a more detailed consideration of the items, as presented in Table 8.11, shows some disadvantages of the STI scales. Considering the item means, it can be said that more than one third of the items have extreme endorsement frequencies (below 25% or above 75%). On the average, the SI scale has the most extreme item endorsement (41.8%), followed by the SE scale (36.4%), and the M scale, having an average

TABLE 8.10
Reliability (Cronbach-Alpha) of the STI-Scales in the German Sample

Studies	N	Sex	Age	SE	SI	M	B
Bielefeld 1 (Anouncement)	173	M	15-80 x=33, SD=13	.85	.87	.78	.87
	218	F	16-80 x=33, SD=13	.81	.83	.75	.78
Bielefeld 2 (Student-course SS 87)	85	M	19-42 x=27, SD=5.6	.78	.72	.80	.65
	75	F	19-47 x=27, SD=6.2	.64	.79	.85	.71
Duesseldorf (Student-course SS 87)	63	M	18-63 x=32, SD=12	.80	.85	.71	
	75	F	17-65 x=31, SD=11.4	.83	.87	.68	
Bielefeld 3 (Student-course WS 87)	37	M	16-58 x=27, SD=8	.87	.84	.77	.83
	100	F	18-66 x=26, SD=8	.81	.82	.76	.79

x = mean age
SD = standard deviation

Note. The reliability score of the B scale was calculated by means of the correlations of the B scores between Form A and Form B of the STI items (split-half reliability).

TABLE 8.11

Item-Statistics of the STI-Scales in the German Studies

			Extreme Item Means (a)			Unsatisfactory Item-Scale Correlations (Corrected) (b)		
			SE	SI	M	SE	SI	M
Study	N	Sex	(44 Items)	(44 Items)	(46 Items)	(44 Items)	(44 Items)	(46 Items)
Bielefeld 1 (Announcement)	173	M	19 (43.2%)	19 (43.2%)	14 (30.4%)	3 (6.8%)	5 (11.4%)	16 (34.8%)
	218	F	18 (40.9%)	18 (40.9%)	14 (30.4%)	8 (18.2%)	9 (20.5%)	22 (47.8%)
Bielefeld 2 (Student-course SS 87)	85	M	15 (34.1%)	21 (47.7%)	7 (15.9%)	17 (38.6%)	19 (43.2%)	18 (39.1%)
	75	F	12 (27.3%)	18 (40.9%)	17 (38.6%)	26 (59.1%)	16 (36.4%)	12 (26.1%)
Duesseldorf (Student-course SS 87)	63	M	19 (43.2%)	24 (54.5%)	11 (23.9%)	13 (29.5%)	9 (20.5%)	26 (56.5%)
	75	F	16 (36.4%)	17 (38.6%)	20 (43.5%)	12 (27.3%)	5 (11.4%)	22 (47.8%)
Bielefeld 3 (Student-course WS 87)	37	M	13 (29.5%)	16 (36.4%)	14 (30.4%)	9 (20.5%)	8 (18.2%)	17 (37.0%)
	100	F	16 (36.4%)	14 (31.8%)	12 (26.1%)	13 (29.5%)	12 (27.3%)	22 (47.8%)
Means			16 (36.4%)	18.4 (41.8%)	12.6 (31%)	12.6 (28.6%)	10.4 (23.6%)	19.4 (42.1%)

Note. (a) Number and percentages of item means revealing extreme endorsements (below 0.50 and above 1.50)
(b) Number and percentages of items with not acceptable corrected item-scale correlations (below 0.20)

Percentages are given in brackets. The age distribution of the samples are given in Table 8.10.

of 31%. The results of our research point to a higher number of extreme item responding as revealed by Paisey and Mangan (1980), and Stelmack et al. (1985) in studies conducted with the English version of the STI.

For considering the item-scale relationships of the STI we have used the Daum and Schugens' (1986) proposal, counting item-scale correlations below .20 as unsatisfactory. As Table 8.11 indicates, the percentage of nonacceptable item-scale correlations varies considerably from sample to sample, especially for the SE and SI scales. The highest mean percentage is found for the M scale (42.1%), followed by SE scale (28.6%), and the SI scale (23.6%). From this rather unsatisfactory result, it may be concluded that the probability that items correlate with scales for which they are not constructed is rather high. Negative item-scale correlations are found, especially in the case of the M scale. Our pattern of results is similar to Daum and Schugens', in that the M scale comprises the highest number of unsatisfactory item-scale relationships.

Correlations between the STI Scales. Inspection of the internal validity of the STI may be carried out by looking at the correlations between the scales. As shown in Table 8.12, the medians of the inter-scale correlations are as follows: SE × SI = .28, SE × M = .48, SI × M = .0, M × B = .39.

There is strong evidence that strength of excitation and mobility, as well as mobility and balance, correlate with each other. The SI scale also shows a

TABLE 8.12
Pearson Correlations of the STI-Scales

Study	N	Sex	Age	SE x SI	SE x M	SI x M	M x B
Bielefeld 1 (Anouncement)	184	M	15-80 x=33, SD=13.5	.38a	.59a	.07	.29a
	244	F	16-80 x=33, SD=13.2	.23a	.48a	-.10	.39a
Bielefeld 2 (Student-course SS 87)	85	M	19-42 x=27, SD=5.6	.08	.46a	-.20c	.49a
	75	F	19-47 x=27, SD=6.2	.38a	.46a	.23c	.15
Duesseldorf (Student-course SS 87)	63	M	18-63 x=32, SD=12	.28c	.53a	.02	.39a
	75	F	17-65 x=31, SD=11.4	.30c	.43a	-.11	.42a
Bielefeld 3 (Student-course WS 87)	37	M	16-58 x=27, SD=8	.37c	.55a	.09	.46b
	100	F	18-66 x=26, SD=8	.28b	.49a	-.05	.44a

a = $p < .001$ x = mean age
b = $p < .01$ SD = standard deviation
c = $p < .05$

considerable positive correlation with the SE scale. Practically no correlation exists between the SI and M scales. This pattern of results is somewhat different from those summarized in Table 8.3. The main differences refer to the degree of the size of the correlations and to the relations between the M and B scales. In our studies, the median correlations, except for the balance scale, are lower, as compared with the median values reported in the literature (Table 8.3). For the correlation between M and B, contradictory results are reported in Table 8.3, whereas our data show rather high positive correlations. Theoretically, the correlations between strength of excitation and mobility seem to be acceptable (see Strelau, 1983), but they are too high for using these scales as measures for separate theoretically distinguished concepts. For the relationship between strength of excitation and strength of inhibition, no clear predictions are deducible from Pavlov's theorizing. However, it is our assumption that these concepts should also be viewed as rather independent from each other, in contrast to our findings (median correlation = .28).

External Validity: STI and the Eysenckian Personality Scales. The personality dimension most often compared with the Pavlovian properties of the nervous system is extraversion, which correlates—in reports to be found in the literature—positively with strength of excitation as well as with mobility (see Table 8.4). As mentioned before, in our studies different instruments were used for measuring extraversion.

Inspection of Table 8.13 reveals that this postulated relationship between extraversion and strength of excitation depends on the extraversion scale used. No significant correlation is found in the case of the EPI-A Form. Coefficients of correlation referring to other extraversion scales indicate a positive and statistically significant correlation, with one exception only (.19). The medians of the coefficients of correlation of all of the extraversion scales with the STI measures are as follows: SE = .34, SI = −.27, M = .48, and B = .45. Also in the literature, the highest coefficients of correlation were recorded in the case of mobility. In all of our samples a negative (usually statistically significant) correlation between extraversion and strength of inhibition occurs, which is in disagreement with studies reported in the literature, where positive as well as negative results were registered, with a median showing zero correlation. The rather high correlation between balance and extraversion may be explained by the circumstance that a high B score implies predominance of strength of excitation over strength of inhibition, By definition (see p. 193), the latter concept refers to control of behavior.

We now turn to the neuroticism dimension as related to the STI scales, the results of which are summarized in Table 8.14. The medians of the coefficients of correlation are: SE × N = −.37, SI × N = −.28, M × N = −.15, and a near-zero correlation (−.01) is found for B with N. This finding replicates the results of former studies presented in Table 8.5.

TABLE 8.13
Pearson Correlation Coefficients Between Extraversion-Scales and the STI-Scales

Study	N	Sex	Age	SE	SI	M	B	Inventory
Bielefeld 1	78	M	20-79 x=38.9, SD=13.9	.19c	-.36a	.46a	.44a	EPQ
	103	F	17-80 x=37.4, SD=14.6	.35a	-.20c	.58a	.33a	EPQ
Bielefeld 2	34	M	19-42 x=25, SD=4	.53a	-.30c	.72a	.60a	FPI-R(E)
	41	F	20-47 x=25, SD=6	.50a	-.19	.62a	.63a	FPI-R(E)
Duesseldorf	62	M	18-63 x=32, SD=12	.17	-.38b	.46a	.48a	EPI-A
	72	F	17-65 x=31, SD=11.4	.10	-.47a	.42a	.47a	EPI-A
	62	M	18-63 x=32, SD=12	.35b	-.15	.45a	.41b	EPI-B
	72	F	17-65 x=31, SD=11.4	.34b	-.27c	.54a	.50a	EPI-B
	62	M	18-63 x=32, SD=12	.19	-.21	.48a	.36b	EPQ
	72	F	17-65 x=31, SD=11.4	.37b	-.25c	.52a	.45a	EPQ
Bielefeld 3	47	F	19-48 x=24, SD=5.6	.01	-.45a	.40b	.33b	EPI-A

a = $p < .001$
b = $p < .01$
c = $p < .05$

x = mean age
SD = standard deviation

TABLE 8.14

Pearson Correlation Coefficients Between Neuroticism-Scales and the STI-Scales

Study	N	Sex	Age	SE	SI	M	B	Inventory
Bielefeld 1	78	M	20-79 x=38.9, SD=13.9	-.37a	-.55a	-.06	.26c	EPQ
	103	F	17-80 x=37.4,SD=14.6	-.35a	-.28b	-.07	-.01	EPQ
Bielefeld 2	34	M	19-42 x=25, SD=4	-.34c	.07	-.32c	-.29c	FPI-R(N)
	41	F	20-47 x=25, SD=6	-.43b	-.23	-.31c	-.17	FPI-R(N)
Duesseldorf	62	M	18-63 x=32, SD=12	-.44a	-.27c	-.26c	-.13	EPI-A
	72	F	17-65 x=31, SD=11.4	-.43a	-.52a	-.13	.11	EPI-A
	62	M	18-63 x=32, SD=12	-.46a	-.19	-.30c	-.19	EPI-B
	72	F	17-65 x=31, SD=11.4	-.37b	-.41a	-.12	.08	EPI-B
	62	M	18-63 x=32, SD=12	-.33b	-.24	-.15	-.06	EPQ
	72	F	17-65 x=31, SD=11.4	-.34b	-.50a	-.12	.16	EPQ
Bielefeld 3	47	F	19-48 x=24, SD=5.6	-.47a	-.46a	-.18	.10	EPI-A

a = $p < .001$
b = $p < .01$
c = $p < .05$

x = mean age
SD = standard deviation

TABLE 8.15
Pearson Correlation Coefficients Between Psychoticism-Scales and the STI-Scales

Study	N	Sex	Age	SE	SI	M	B	Inventory
Bielefeld 1	78	M	20-79 x=38.9, SD=13.9	-.21c	-.60a	.17	.40a	EPQ
	103	F	17-80 x=37.4, SD=14.6	.06	-.39a	.13	.36a	EPQ
Duesseldorf	62	M	18-63 x=32, SD=12	.00	-.20	.03	.22	EPQ
	72	F	17-65 x=31, SD=11.4	.21	-.34b	.25c	.47a	EPQ

a = $p < .001$ x = mean age
b = $p < .01$ SD = standard deviation
c = $p < .05$

The negative correlation between strength of excitation and neuroticism is expected if one considers the conceptualization of this CNS property. The relatively high negative correlations between strength of inhibition and the neuroticism scales may be viewed as indicating a lack of discriminant validity in the STI scales.

Psychoticism as measured by the EPQ shows inconsistent data for the SE scale and consistent patterns of results for the remaining STI measures (see Table 8.15).

The coefficients of correlation for psychoticism and strength of excitation vary from −.21 to .21, a finding that may be expected when looking at Table 8.7. Highly significant correlations came up in the negative direction for strength of inhibition and in a positive one for balance. These results are in agreement with our hypothesis (see p. 211).

External Validity: STI and the Sensation Seeking Scales. When following Zuckerman's (1979) theorizing, a positive correlation between sensation seeking and strength of excitation may be expected. This has been partially proven by our results, as revealed in Table 8.16. The significant correlations between the sensation seeking scales—Total (TO), Thrill and Adventure Seeking (TAS), Experience Seeking (ES) and Boredom Susceptibility (BS)—are positive, indicating some relationships between these concepts under discussion. The Disinhibition scale (Dis) shows no correlation with the SE measure, a finding that replicates the results of earlier studies (see Table 8.8). The SI scale, in general, correlates negatively with the SS scales. However, among the 20 coefficients comprising the four samples, only half of them reach the level of statistical significance.

Also the mobility scale points to high positive correlations with the sensation seeking scales. The only exception is one significant negative correlation to be found for the Dis scale (−.47). This configuration of the correlation coefficients replicates the findings obtained in former studies (see Table 8.8). However, one may speculate as to why our correlations are considerably higher than those reported in the literature. It might be due to the German speaking versions of our tests. This reasoning has some support in the data published by Daum et al. (1988)

TABLE 8.16

Pearson Correlation Coefficients Between Sensation-Seeking-Scales and the STI-Scales

No.	TO	TAS	SE ES	Dis	BS	TO	TAS	SI ES	Dis	BS	TO	TAS	M ES	Dis	BS	TO	TAS	B ES	Dis	BS
1.	.24	.24	.27c	.07	.12	-.12	-.10	-.11	-.15	-.02	.27c	.25c	.29c	.19	.06	.33b	.29c	.33b	.26c	.13
2.	.31b	.33b	.32b	.12	.23c	-.32	-.03	-.31b	-.47a	-.25c	.42a	.31b	.39b	.33b	.34b	.49a	.27c	.48a	.49a	.37b
3.	.29c	.66a	.01	-.20	.26c	-.57a	-.23	-.55a	-.45a	-.27c	.10	.40b	.00	-.47a	.52a	.62a	.73a	.37b	.07	.43a
4.	-.03	-.05	-.04	-.06	-.05	-.63a	-.45a	-.21	-.17	-.72a	.48b	.70a	.01	-.14	.35c	.51a	.37c	.21	.09	.58a

1. Duesseldorf; SSS-IV; 62 males (18-63); mean age = 32; SD = 12
2. Duesseldorf; SSS-IV; 72 females (17-65); mean age = 31; SD = 11.4
3. Bielefeld 2; SSS-V; 51 males (20-36); mean age = 29; SD = 6
4. Bielefeld 2; SSS-V; 34 females (19-45); mean age = 29; SD = 6

a = $p < .001$
b = $p < .01$
c = $p < .05$

showing also higher correlations between the STI scales and the sensation seeking scales, as compared with studies using other language versions.

The largest number of significant correlations occurred for the balance measure. Here almost all coefficients indicate highly significant positive correlations. This profile of results is not expected from former studies, where, in general, no relationships were found. It is, however, consistent with conclusions to be drawn from other findings. For example, positive correlations between balance and psychoticism were found in our studies, and as known from the literature, correlations of the same direction are reported between sensation seeking and psychoticism (see e.g., Zuckerman, 1979, Table 6.7).

External Validity: STI and the Content Scales of the Personality Research Form (PRF). The correlational patterns for the STI and the PRF scales are highly similar for men and women. The data are given in Table 8.17.

In general, it has to be stated that many statistically significant correlations have been found between the STI and the PRF scales. Fifty-five percent of the correlations for the male sample and 52% for the female sample are statistically significant. The large number of significant correlations does not allow us to discuss them in detail. Therefore, only some general trends are presented.

The SE scale correlates positively with achievement (Ac), dominance (Do), endurance (En), and exhibition (Ex), and negatively with harmavoidance (Ha) and succorance (Su). Because strength of excitation is regarded as an activity-oriented temperament dimension (Mangan, 1982; Strelau, 1983) and characterized by Pavlov (1951–52) as endurance in the face of strong stimuli, our results are in agreement with this hypothesizing.

The profile of correlations for the SI scale clearly reveals the impulse control mechanism underlying the concept of inhibition. The PRF aggression (Ag), Ex, impulsivity (Im), play (Pl), social recognition (Sr), and Su scales show consistently, and in both samples, a significant negative correlation, whereas the En and the Order (Or) scales exhibit a positive correlation with the SI scale.

An inspection of the correlation of the mobility scale with the PRF scales seems to suggest that interpersonal relation characteristics are significantly correlated with this Pavlovian property. The PRF Af, Do, Ex, Im, nurturance (Nu), and Pl scales are positively correlated with mobility and the Ha scale is negatively correlated with mobility.

The correlations between the balance measure and the PRF scales are also similar for both sexes. Significant positive correlations are found for Ac, Ag, Do, Ex, and Im scales, whereas negative correlations are found between the Ha scale and the B measure. One may speculate that the balance property is related to ascendance striving.

The STI Scales and Response Distortions. First, we consider the correlations between the different lie (L) scales used in the Eysenckian inventories and the STI scales. These correlations are presented in Table 8.18.

TABLE 8.17

Pearson Correlation Coefficients Between the STI-Scales and the Scales of the PRF for the Bielefeld I (Announcment) Sample

Scales	Men (N = 130, Mean Age = 34.4, Range = 18-80 years, SD = 13.4) SE	SI	M	B	Women (N = 165, Mean Age = 34.4, Range = 16-80 years, SD = 14.3) SE	SI	M	B
PRF-Content-Scales								
Ac	.46a		.15c	.24a	.41a	.17c		.21b
Af	.26b		.34a	.26b		-.16c	.41a	
Ag	-.21b	-.59a		.40a		-.50a		.43a
Do	.53a		.33a	.43a	.51a		.30a	.42a
En	.51a	.27b			.56a	.33a		
Ex	.24b	-.27b	.39a	.44a	.37a	-.25b	.47a	.46a
Ha	-.24b		-.38a	-.27b	-.17c		-.21b	-.26a
Im		-.51a	.29a	.38a		-.46a	.25a	.23b
Nu	.27b		.17c	.15c			.17c	
Od	.21b	.24b				.14c		
Pl		-.23b	.22b			-.19b	.41a	
Sr		-.24b			-.28a	-.20b		
Su	-.24b	-.23b			-.35a	-.19b		-.14c
Un	.17c				.15c	.14c		
PRF-Control-Scales								
In					-.17c			-.17c
Sd	.43a	.43a			.27b	.44a		-.18c

Note. Only significant correlations are given. a = $p < .001$, b = $p < .01$, c = $p < .05$

The SE scale shows only one significant correlation (for men). All other correlations are about zero. However, a different picture emerges considering the SI scale. Especially the female samples point to a significant positive relationship between the L scales and strength of inhibition scales. This may suggest that, especially for women, SI values may be regarded as indicators of response distortions. Also the M scale shows again that the female samples generally exhibit significant negative correlations to a higher degree than do the males, and therefore, the mobility scale may also suffer from response distortions. Furthermore, the female samples again are the only ones that show significant correlations of negative value with the L scales.

Second, we turn to the results of the PRF control scales, infrequency (In) and desirability (Sd), related to the STI scales (see Table 8.17). Jackson (1967) defines infrequency in terms of careless responding, whereas desirability is characterized by describing oneself in a favorable, socially desirable manner.

The infrequency control scale shows a negative correlation with the SE and B scales for the women sample only, a pattern that corresponds to the previously mentioned results.

Taking in account the correlations of the STI scales with the Sd measure, it may be stated that the SE and SI scales are highly positively correlated with this control scale for both sexes. This consistent finding suggests that, for the future, more attention should be paid to the desirability aspect of the STI item content.

CONCLUSIONS AND RECOMMENDATIONS

Research conducted until now shows that it is a scientifically fruitful approach to assess temperament traits according to Pavlov's conceptualization of nervous system properties, and for comparing them with personality/temperament dimensions as developed in the West. It may be noted, that the STI is until now the only inventory that allows such comparisons on a psychometric level. Behavioral and laboratory studies in which the STI was used point to the promising predictive validity of this inventory, especially of the SE scale.

The construction of the Strelau Temperament Inventory, primarily developed for use in the Warsaw Laboratory for Individual Differences, was originally not guided by advanced psychometric personality scale construction strategies, as suggested by Angleitner, John, and Loehr (1986). After the presentation of the STI in English by Strelau (1972a, 1983), this inventory became increasingly popular in Eastern Europe as well as in Western countries. However, in reviewing the evidence on the STI, it became clear that this inventory has the following disadvantages:

1. On the item level, too many items show extreme endorsements.
2. The item-content, at least of the German and English versions, is too much

TABLE 8.18

Pearson Correlation Coefficients Between Lie-Scales and the STI Scales

Study	N	Sex	Age	SE	SI	M	B	Inventory
Bielefeld 1	78	M	20-79 x=38.9,SD=13.9	.33a	.44a	-.03	-.15	EPQ
	103	F	17-80 x=37.4,SD=14.6	-.00	.31a	-.22c	-.27b	EPQ
Bielefeld 2	34	M	19-42 x=25,SD=4	-.08	-.28c	.17	.13	FPI-R(10) reversed keying
	41	F	20-47 x=25,SD=6	-.08	-.29c	-.00	.20	FPI-R(10) reversed keying
Duesseldorf	62	M	18-63 x=32,SD=12	.03	.21	-.18	-.20	EPI-A
	72	F	17-65 x=31,SD=11.4	.21	.51a	-.31b	-.29c	EPI-A
	62	M	18-63 x=32,SD=12	-.05	.04	-.26c	-.10	EPI-B
	72	F	17-65 x=31,SD=11.4	.15	.39a	-.37b	-.24c	EPI-B
	62	M	18-63 x=32,SD=12	-.02	.10	-.31c	-.13	EPQ
	72	F	17-65 x=31,SD=11.4	.18	.39a	-.30c	-.17	EPQ
Bielefeld 3	47	F	19-48 x=24,SD=5.6	.24	.29c	.08	-.04	EPI-A

a = $p<.001$ x = mean age
b = $p<.01$ SD = standard deviation
c = $p<.05$

restricted to behavior in work and occupational situations in order to constitute a representative sample of the universe of human conduct.

3. Many items have rather low, unsatisfactory item-scale correlations, and a high number of items correlate higher with other STI scales than with the one they are constructed for.
4. The scales contain too many items as compared with contemporary personality/temperament scales.
5. The STI scales correlate with each other to a higher degree than theoretically expected—this is especially true for the SE and M scales.
6. The scales show high correlations with social desirability responding.
7. The scales are not balanced in the keying, showing extreme predominance of "yes."
8. The use of the question mark in the answering format for counting one point is ambiguous from an interpretational viewpoint, and is not empirically valid.

Taking into account that the Pavlovian concepts are probably scientifically fruitful, gaining more and more attractiveness, and having in mind the disadvantages of the current STI, the authors conclude: (1) the current STI may be considered as unsatisfactory, and (2) a new STI should be constructed, based on current theorizing about personality scale development and on advanced psychometric strategies (Angleitner & Wiggins, 1986).

Further studies that lead to the construction of the new, revised version of the Strelau Temperament Inventory (STI-R) as well as a detailed description of the steps in developing this new instrument will be reported in the near future. The program of developing the STI-R[8] is based on a cross-cultural approach, by studying simultaneously different language versions in different cultures.

ACKNOWLEDGMENTS

We would like to thank Robert A. Wicklund for helpful comments on an earlier version of this manuscript.

Correspondence concerning this chapter should be sent to Jan Strelau, University of Warsaw, Faculty of Psychology, Stawki 5-7, 00-183 Warsaw, Poland.

REFERENCES

Andresen, B. (1986). Reizsuche- und Erlebnismotive I: Eine psychometrische Reanalyse der SSS V Zuckermans im Kontext der MISAP-Entwicklung. *Zeitschrift fuer Differentielle und Diagnostische Psychologie, 7,* 177–203.

Angleitner, A., John, O. P., & Loehr, F. J. (1986). It's *what* you ask and *how* you ask it: An

[8]The experimental version of the STI-R may be obtained by writing to the authors.

itemmetric analysis of personality questionnaires. In A. Angleitner, & J. S. Wiggins (Eds.), *Personality assessment via questionnaires: Current issues in theory and measurement (pp. 61–107)*. New York: Springer Verlag.

Angleitner, A., & Wiggins, J. S. (Eds.). (1986). *Personality assessment via questionnaires: Current issues in theory and measurement*. New York: Springer Verlag.

Barclay, J. R. (1987). The Strelau Temperament Inventory as a broad classification system. *Archives of Clinical Neuropsychology, 2,* 307–327.

Beauvale, A., & Placzynta, M. (1986). Relation between stimulus intensity and simple reaction time contingent upon basic nervous system properties. *Polish Psychological Bulletin, 17,* 55–61.

Birman, B. N. (1951). An attempt to make a clinico-physiological determination of types of higher nervous activity. *Zhurnal Vysshei Nervnoi Deyatelnosti, 1,* 879–888 (in Russian).

Carlier, M. (1985). Factor analysis of Strelau's Questionnaire and an attempt to validate some of the factors. In J. Strelau, F. H. Farley, & A. Gale (Eds.), *The biological bases of personality and behavior: Theories, measurement techniques, and development* (Vol. 1, pp. 145–160). Washington: Hemisphere.

Cattell, R. B. (1972). The interpretation of Pavlov's typology and the arousal concept, in replicated trait and state factors. In V. D. Nebylitsyn, & J. A. Gray (Eds.), *Biological bases of individual behavior* (pp. 141–164). New York: Academic Press.

Chudnovsky, V. E. (1963). The study of nervous system type's properties in children. *Voprosy Psikhologii, 3,* 5–20 (in Russian).

Ciosek, M., & Oszmianczuk, J. (1974). Wlasciwosci procesow nerwowych a ekstrawersja i neurotyzm [Nervous system properties and extraversion and neuroticism]. *Przeglad Psychologiczny, 17,* 235–246.

Claridge, G. (1985). *Origins of mental illness: Temperament, deviance and disorder*. New York: Basil Blackwell.

Claridge, G. (1987). Psychoticism and arousal. In J. Strelau, & H. J. Eysenck (Eds.), *Personality dimensions and arousal* (pp. 133–150). New York: Plenum Press.

Corulla, W. J. (1989). The relationships between the Strelau Temperament Inventory, sensation seeking and Eysenck's dimensional system of personality. *Personality and Individual Differences, 10,* 161–173.

Cytawa, J. (1959). Badanie typu ukladu nerwowego czlowieka na podstawie wywiadu [The study of the nervous system type in man based on an interview]. *Annales Universitatis Mariae Curie-Sklodowska, 14,* 137–156.

Dall, P. J., & White, K. D. (1985). Mobility, extraversion, and neuroticism. *The Pavlovian Journal of Biological Science, 20,* 171–176.

Davydova, A. N. (1954). Monographic study of children with features of various types of nervous system. *Izvestiya Academii Pedagogicheskikh Nauk RSFSR, 52,* 141–183 (in Russian).

Daum, I., Hehl, F. J., & Schugens, M. M. (1988). Construct validity and personality correlates of the Strelau Temperament Inventory. *European Journal of Personality, 2,* 205–216.

Daum, I., & Schugens, M. M. (1986). The Strelau Temperament Inventory (STI): Preliminary results in a West German sample. *Personality and Individual Differences, 7,* 509–517.

Eggert, D. (1974). *Eysenck-Persoenlichkeits-Inventar (E-P-I): Handanweisung fuer die Durchfuehrung und Auswertung*. Goettingen: C. J. Hogrefe.

Eliasz, A. (1985a) Mechanisms of temperament: Basic functions. In J. Strelau, F. Farley, & A. Gale (Eds.), *The biological bases of personality and behavior: Theories, measurement techniques, and development* (Vol. 1, pp. 45–59). Washington: Hemisphere.

Eliasz, A. (1985b). Transactional model of temperament. In J. Strelau (Ed.), *Temperamental bases of behavior: Warsaw studies on individual differences* (pp. 41–78). Lisse: Swets & Zeitlinger.

Eliasz, A. (1987). Temperament-contingent cognitive orientation toward various aspects of reality. In J. Strelau, & H. J. Eysenck (Eds.), *Personality dimensions and arousal* (pp. 197–213). New York: Plenum Press.

Eysenck, H. J. (1947). *Dimensions of personality*. London: Kegan Paul, Trench, Trubner and Co.

Eysenck, H. J. (1966). *Conditioning, introversion-extraversion and the strength of the nervous system*. Paper presented at the meeting of the International Congress of Psychology, Moscow, SU.

Eysenck, H. J. (1970). *The structure of human personality*. London: Methuen.

Eysenck, H. J. (1972). Human typology, higher nervous activity, and factor analysis. In V. D. Nebylitsyn, & J. A. Gray (Eds.), *Biological bases of individual behavior* (pp. 165–181). New York: Academic Press.

Eysenck, H. J. (1987). [Special review of *Temperamental bases of behavior: Warsaw studies on individual differences & The biological bases of personality and behavior* (Vol. 1 & 2)]. *Personality and Individual Differences, 8*, 289–290.

Eysenck, H. J., & Eysenck, M. W. (1985). *Personality and individual differences: A natural science approach*. New York: Plenum Press.

Eysenck, H. J., & Levey, A. (1972). Conditioning, introversion-extraversion and the strength of the nervous system. In V. D. Nebylitsyn, & J. A. Gray (Eds.), *Biological bases of individual behavior* (pp. 206–220). New York: Academic Press.

Fahrenberg, J. (1987). Concepts of activation and arousal in the theory of emotionality (neuroticism): A multivariate conceptualization. In J. Strelau, & H. J. Eysenck (Eds.), *Personality dimensions and arousal* (pp. 99–120). New York: Plenum Press.

Fahrenberg, J., Hampel, R., & Selg, H. (1984). *Das Freibuerger Persoenlichkeitsinventar FPI. Revidierte Fassung FPI-R und teilweise geaenderte Fassung FPI—A1: Handanweisung*. Goettingen: C. J. Hogrefe.

Fahrenberg, J., Walschburger, P., Foerster, F., Myrtek, M., & Mueller, W. (1983). An evaluation of trait, state, and reaction aspects of activation processes. *Psychophysiology, 20*, 188–195.

Fedorov, V. K. (1961). Comparison of results of different studies of basic properties of higher nervous activity in mice. *Zhurnal Vysshei Nervnoi Deyatelnosti, 11*, 746–752 (in Russian).

Fiske, D. W., & Maddi, S. R. (Eds.). (1961). *Functions of varied experience*. Homewood: Dorsey Press.

Friedensberg, E. (1985). Reactivity and individual style of work exemplified by constructional-type task performance: A developmental study. In J. Strelau, F. H. Farley, & A. Gale (Eds.), *The biological bases of personality and behavior: Theories, measurement techniques, and development* (Vol. 1, pp. 241–253). Washington: Hemisphere.

Frigon, J. Y. (1976). Extraversion, neuroticism and strength of the nervous system. *British Journal of Psychology, 67*, 467–474.

Gilliland, K. (1985). The Temperament Inventory: Relationship to theoretically similar Western personality dimensions and construct validity. In J. Strelau, F. H. Farley, & A. Gale (Eds.), *The biological bases of personality and behavior: Theories, measurement techniques, and development* (Vol. 1, pp. 161–170). Washington: Hemisphere.

Goldman, D., Kohn, P. M., & Hunt, R. W. (1983). Sensation seeking, augmenting-reducing, and absolute auditory threshold: A strength-of-the-nervous-system perspective. *Journal of Personality and Social Psychology*, 45, 405–411.

Golubeva, E. A. (1980). Some problems of the experimental study of the inborn prerequisites of general capacities. *Voprosy Psikhologii, 26*, 23–37 (in Russian).

Gray, J. A. (Ed.). (1964). *Pavlov's typology*. Oxford: Pergamon Press.

Gray, J. A. (1967). Strength of the nervous system, introversion-extraversion, conditionability and arousal. *Behavior Research and Therapy, 5*, 151–169.

Gupta, S., & Nicholson, J. (1985). Simple visual reaction time, personality and strength of the nervous system: A signal-detection theory approach. *Personality and Individual Differences, 6*, 461–469.

Haase, R. F. (1986). Polychronicity and strength of the nervous system as predictors of information overload. In J. Strelau, F. H. Farley, & A. Gale (Eds.), *The biological bases of personality and behavior: Psychophysiology, performance, and application* (Vol. 2, pp. 135–142). Washington: Hemisphere.

Halmiova, O., & Sebova, E. (1986). Nervous system properties and coding processes. In J. Strelau, F. H. Farley, & A. Gale (Eds.), *The biological bases of personality and behavior: Psychophysiology, performance, and application* (Vol. 2, 127–134). Washington: Hemisphere.

Ivanov-Smolensky, A. G. (1935). The experimental investigation of higher nervous activity in children. *Fiziologicheskii Zhurnal SSSR, 19*, 133–140 (in Russian).

Jackson, D. N. (1967). *Manual for the Personality Research Form*. Goshen: Research Psychologists Press.

Karpova, A. K. (1974). Generality and specificity in mathematical interrelations of orthogonal indices of temperament features in different social-developmental samples. In V. S. Merlin (Ed.), *The problems of temperament theory* (pp. 42–86). Perm: MP RSFSR & PGPI (in Russian).

Keuss, P. J. G., & Orlebeke, J. F. (1977). Transmarginal inhibition in a reaction time task as a function of extraversion and neuroticism. *Acta Psychologica, 41*, 139–150.

Klonowicz, T. (1974). Reactivity and fitness for the occupation of operator. *Polish Psychological Bulletin, 5*, 129–136.

Klonowicz, T. (1979). "Kwestionariusz do badania temperamentu" J. Strelaua—proba badan miedzykulturowych [Strelau Temperament Inventory: An attempt at cross-cultural studies]. *Studia Psychologiczne, 18*, 83–92.

Klonowicz, T. (1985). Temperament and performance. In J. Strelau (Ed.), *Temperamental bases of behavior: Warsaw studies on individual differences* (pp. 79–115). Lisse: Swets & Zeitlinger.

Klonowicz, T. (1986). Reactivity and performance: The third side of the coin. In J. Strelau, F. H. Farley, & A. Gale (Eds.), *The biological bases of personality and behavior: Psychophysiology, performance, and application* (Vol. 2, pp. 119–126). Washington: Hemisphere.

Klonowicz, T. (1987). Reactivity and the control of arousal. In J. Strelau, & H. J. Eysenck (Eds.), *Personality dimensions and arousal* (pp. 183–196). New York: Plenum Press.

Kohn, P. M. (1987). Issues in the measurement of arousability. In J. Strelau, & H. J. Eysenck (Eds.), *Personality dimensions and arousal* (pp. 233–250). New York: Plenum Press.

Kohn, P. M., Cowles, M. P., & Lafreniere, K. (1987). Relationships between psychometric and experimental measures of arousability. *Personality and Individual Differences, 8*, 225–231.

Kolesnikov, M. S. Material on the description of the weak type of nervous system. *Trudy Instituta Fiziologii im. I. P. Pavlova, 2*, 120–135 (in Russian).

Kolesnikov, M. S., & Troshikhin, V. A. (1951). The small standard battery of tests for determining type of higher nervous activity in the dogs. *Zhurnal Vysshei Nervnoi Deyatelnosti, 1*, 739–743 (in Russian).

Kopytova, L. A. (1963). Expression of typological properties of the nervous system in the activity of machine operators when machines are idle. *Voprosy Psikhologii, 9*, 59–72 (in Russian).

Koscielak, R. (1979). The role of nervous system traits in inventive creativity. *Polish Psychological Bulletin, 10*, 225–232.

Kovac, D., & Halmiova, O. (1973). Is there a direct correlation between emotional stability and strength of nervous processes? *Studia Psychologica, 15*, 1–7.

Kozlowski, C. (1977). Demand for stimulation and probability preferences in gambling decisions. *Polish Psychological Bulletin, 8*, 67–73.

Krasnogorsky, N. I. (1953). Typological properties of higher nervous activity in children. *Zhurnal Vysshei Nervnoi Deyatelnosti, 3*, 169–183 (in Russian).

Krasusky, V. K. (1971). On some additional criteria of assessment of higher nervous activity properties. In V. K. Krasusky, & V. K. Fedorov (Eds.), *Methods of assessment of higher nervous activity properties* (pp. 64–72). Leningrad: Nauka (in Russian).

Krushinsky, L. V. (1947). Inheritance of passive-defensive behavior (cowardice) as connected with types of nervous system in the dog. *Trudy Instituta Evolutsionnoi Fiziologii i Patologii im. I. P. Pavlova, 1*, 39–62 (in Russian).

Kupalov, P. S. (1952). Experimental neuroses in animals. *Zhurnal Vysshei Nervnoi Deyatelnosti, 2*, 457–473 (in Russian).

Lacey, J. I. (1950). Individual differences in somatic response patterns. *Journal of Comparative and Physiological Psychology, 43,* 338–350.

Lacey, J. I. (1967). Somatic response patterning and stress: Some revisions of activation theory. In M. H. Appley, & R. Trumbull (Eds.), *Psychological stress: Issues in research* (pp. 14–37). New York: Appleton-Century-Crofts.

Larsen, R. J., & Baggs, D. W. (1986). Some psychophysical and personality correlates of the Strelau Temperament Inventory. *Personality and Individual Differences, 7,* 561–565.

Leites, N. S. (1956). An attempt to give a psychological description of temperaments. In B. M. Teplov (Ed.), *Typological features of higher nervous activity in man* (Vol. 1, pp. 267–303). Moscow: RSFSR Academy of Pedagogical Sciences (in Russian).

Loo, R. (1979). Neo-Pavlovian properties of higher nervous activity and Eysenck's personality dimensions. *International Journal of Psychology, 14,* 265–274.

Mangan, G. L. (1967). Studies of the relationship between neo-Pavlovian properties of higher nervous activity and Western personality dimensions: IV. A factor analytic study of extraversion and flexibility, and the sensitivity and mobility of the nervous system. *Journal of Experimental Research in Personality, 2,* 124–127.

Mangan, G. L. (1978). The relationship of mobility of inhibition to rate of inhibitory growth and measures of flexibility, extraversion, and neuroticism. *Journal of General Psychology, 99,* 271–279.

Mangan, G. L. (1982). *The biology of human conduct: East-West models of temperament and personality.* Oxford: Pergamon Press.

Mangan, G. L., & Farmer, R. G. (1967). Studies of the relationship between neo-Pavlovian properties of higher nervous activity and Western personality dimensions: I. The relationship of nervous strength and sensitivity to extraversion. *Journal of Experimental Research in Personality, 2,* 101–106.

Marton, L., & Urban, J. (1966). The relationship between typological personality traits and characteristics of the process of elaboration and extinction of conditioned links. *Voprosy Psikhologii, 12,* 92–100 (in Russian).

Muendelein, H. (1982). *Simulierte Arbeitssituation an Bildschirmterminals: Ein Beitrag zu einer okologisch orientierten Psychologie.* Frankfurt/Main: Fischer Verlag.

Murray, H. A. (1938). *Explorations in personality.* New York: Oxford University Press.

Nebylitsyn, V. D. (1959). Relationship between strength and sensitivity of the nervous system. In B. M. Teplov (Ed.), *Typological features of higher nervous activity in man.* (Vol. 2, pp. 48–82). Moscow: RSFSR Academy of Pedagogical Sciences (in Russian).

Nebylitsyn, V. D. (1960). Reaction time and strength of nervous system. *Doklady Akademii Pedagogicheskikh Nauk RSFSR, 4,* 93–100; *5,* 71–74 (in Russian).

Nebylitsyn, V. D. (1972a). *Fundamental properties of the human nervous system.* New York: Plenum Press.

Nebylitsyn, V. D. (1972b). The problem of general and partial properties of the nervous system. In V. D. Nebylitsyn, & J. A. Gray (Eds.), *Biological bases of individual behavior* (pp. 400–417). New York: Academic Press.

Nosal, C. S. (1974). Interrelation of features of controlled movements and overt properties of the central nervous system (CNS). *Polish Psychological Bulletin,* 5, 137–141.

Oleszkiewicz-Zsurzs, Z. (1984). *Zapotrzebowanie na stymulacje a preferencje do wyboru zawodu* [Need for stimulation and preferences in choice of profession]. Unpublished doctoral dissertation. University of Warsaw, Warsaw.

Orlebeke, J. F. (1972). *Aktivering, extraversie en sterke van het zenuwstelsel* [Arousal, extraversion and strength of the nervous system]. Assen: Van Gorcum and Comp.

Paisey, T. J. H., & Mangan, G. L. (1980). The relationship of extraversion, neuroticism, and sensation seeking to questionnaire-derived measures of nervous system properties. *Pavlovian Journal of Biological Science, 15,* 123–130.

Paisey, T. J. H., & Mangan, G. L. (1982). Neo-Pavlovian temperament theory and the biological bases of personality. *Personality and Individual Differences, 3*, 189–203.

Pavlov, I. P. (1951–1952). *Complete works* (2nd ed.). Moscow & Leningrad: SSSR Academy of Sciences (in Russian).

Pawlow, I. P. (1952). *Dwadziescia lat badan wyzszej czynnosci nerwowej (zachowania sie) zwierzat* [Twenty-five years of objective study of the higher activity (behavior) in animals]. Warszawa: Panstwowy Zaklad Wydawnictw Lekarskich.

Pervomaysky, B. Ya. (1964). Methods of assessment of the type of nervous system in man. In (no editor) *Clinic problems, pathophysiology and treatment of psychological diseases*. Lugansk: Lugansk Medical College Press.

Peysakhov, N. N. (1974). The diagnosis of strength of the excitatory process by means of motor-reaction methods. In N. N. Peysakhov, V. M. Shardin, & A. P. Kashin (Eds.), *Problems of psychology of individual differences*. Kazan: Kazan University Press (in Russian).

Przymusinski, R., & Strelau, J. (1986). Temperamental traits and strategies of decision-making in gambling. In A. Angleitner, A. Furnham, & G. VanHeck (Eds.), *Personality psychology in Europe: Current trends and controversies* (Vol. 2, pp. 225–236). Lisse: Swets & Zeitlinger.

Rawlings, D. (1987). Four experiments on the relation between Eysenck's psychoticism dimension and the Pavlovian concept of nervous system mobility. *Journal of Research in Personality, 21*, 114–126.

Richards, M. (1986). Relationships between the Eysenck Personality Questionnaire, Strelau Temperament Inventory and Freiburger Beschwerdenliste Gesamtform. *Personality and Individual Differences, 7*, 587–589.

Rozhdestvenskaya, V. I. (1963). Typological features in the nervous system of man during the development of delayed photochemical reflexes. In B. M. Teplov (Ed.), *Typological features of higher nervous activity in man* (Vol. 3, pp. 117–132). Moscow: RSFSR Academy of Pedagogical Sciences (in Russian).

Ruch, W. (1988). *Deutsche Erprobungsfassung des EPQ von Eysenck*. Unpublished manuscript, University of Duesseldorf, Department of Psychology, Duesseldorf.

Sales, S. M., & Throop, W. F. (1972). The relationship between kinesthetic aftereffects and strength of the nervous system. *Psychophysiology, 9*, 492–497.

Samarin, Yu. A. (1954). An attempt at the experimental psychological study of typological features of the nervous system in children. *Izvestiya Akademii Pedagogicheskikh Nauk RSFSR, 52*, 81–140 (in Russian).

Saprykin, P. G., & Mileryan, E. A. (1954). *An attempt to develop a method for the experimental investigation of individual features of higher nervous activity in man*. Proceedings of a conference on psychology held on 3-8 July, 1953. Moscow: RSFSR Academy of Pedagogical Sciences (in Russian).

Schoenpflug, W., & Muendelein, H. (1986). Activity and reactivity: Theoretical comments and an experimental approach. In J. Strelau, F. H. Farley, & A. Gale (Eds.), *The biological bases of personality and behavior: Psychophysiology, performance, and application* (Vol. 2, pp. 213–218). Washington: Hemisphere.

Schulz, P. (1986). Activity structures as related to individual differences in temperament. In J. Strelau, F. H. Farley, & A. Gale (Eds.), *The biological bases of personality and behavior: Psychophysiology, performance, and application* (Vol. 2, pp. 219–226). Washington: Hemisphere.

Sosnowski, T., & Wrzesniewski, K. (1986). Research with the Polish form of the State Trait Anxiety Inventory. In C. D.) Spielberger, & R. Diaz-Guerrero (Eds.) *Cross-cultural anxiety* (Vol. 3, pp. 21–35). Washington: Hemisphere.

Spence, K. W. (1956). *Behavior theory and conditioning*. New Haven: Yale University Press.

Stawowska, L. (1973). *Diagnoza typow osobowosci* [The diagnosis of personality types]. Kielce: Wydawnictwo Uniwersytetu Slaskiego.

Stawowska, L. (1977). *Rola zroznicowania typologicznego w funkcjonowaniu jednostki* [The role of typological differentiation in the individual's functioning]. Opole: Wydawnictwo WSP.

Stelmack, R. M., Kruidenier, B. G., & Anthony, S. B. (1985). A factor analysis of the Eysenck Personality Questionnaire and the Strelau Temperament Inventory. *Personality and Individual Differences, 6*, 657–659.

Strelau, J. (1965a). *Problemy i metody badan typow ukladu nerwowego czlowieka* [Problems and methods of research into types of nervous system in man]. Wroclaw: Ossolineum.

Strelau, J. (1965b). *O temperamencie i jego poznawaniu* [On temperament and its diagnosis]. Warszawa: Nasza Ksiegarnia.

Strelau, J. (1969). *Temperament i typ ukladu nerwowego* [Temperament and type of nervous system]. Warszawa: Panstwowe Wydawnictwo Naukowe.

Strelau, J. (1970). Nervous system type and extraversion-introversion: A comparison of Eysenck's theory with Pavlov's typology. *Polish Psychological Bulletin, 1*, 17–24.

Strelau, J. (1972a). A diagnosis of temperament by nonexperimental techniques. *Polish Psychological Bulletin, 3*, 97–105.

Strelau, J. (1972b). The general and partial nervous system types—Data and theory. In V. D. Nebylitsyn, & J. A. Gray (Eds.), *Biological bases of individual behavior* (pp. 62–73). New York: Academic Press.

Strelau, J. (1982). Biologically determined dimensions of personality or temperament? Personality and Individual Differences, 3, 355–360.

Strelau, J. (1983). *Temperament—personality—activity*. London: Academic Press.

Strelau, J. (1984). *Das Temperament in der psychischen Entwicklung*. Berlin: Volk und Wissen Volkseigener Verlag.

Strelau, J. (1987a). The concept of temperament in personality research. *European Journal of Personality*, 1, 107–117.

Strelau, J. (1987b). Personality dimensions based on arousal theories: Search for integration. In J. Strelau, & H. J. Eysenck (Eds.), *Personality dimensions and arousal*. New York: Plenum Press.

Strelau, J., & Terelak, J. (1974). The alpha-index in relation to temperamental traits. *Studia Psychologica, 16*, 40–50.

Strykowska, M. (1978). Effect of reactivity on choice of strategy in solving typical operators' tasks. *Polish Psychological Bulletin*, 9, 139–145.

Stumpf, H., Angleitner, A., Wieck, T., Jackson, D. N., & Beloch-Till, H. (1985). *Deutsche Personality Research Form (PRF): Handanweisung*. Goettingen: C. J. Hogrefe.

Teplov, B. M. (1963). New data for the study of nervous system properties in man. In B. M. Teplov (Ed.), *Typological features of higher nervous activity in man* (Vol. 3, pp. 3–46). Moscow: RSFSR Academy of Pedagogical Sciences (in Russian).

Teplov, B. M. (1964). Problems in the study of general types of higher nervous activity in man and animals. In J. A. Gray (Ed.), *Pavlov's typology* (pp. 3–153). Oxford: Pergamon Press.

Teplov, B. M. (1972). The problems of types of human higher nervous activity and methods of determining them. In V. D. Nebylitsyn, & J. A. Gray (Eds.), *Biological bases of individual behavior* (pp. 1–10). New York: Academic Press.

Teplov, B. M., & Nebylitsyn, V. D. (1963). The study of basic properties of the nervous system and their significance in psychology of individual differences. *Voprosy Psikhologii, 9*, 38–47 (in Russian).

Terelak, J. (1974). Reaktywnosc mierzona indeksem alfa a cechy temperamentalne [Alpha index as a measure of reactivity and temperament features]. In J. Strelau (Ed.), *Rola cech temperamentalnych w dzialaniu* (pp. 45–70). Wroclaw: Ossolineum.

Troshikhin, V. A., Moldavskaya, S. I., & Kolchenko, N. V. (1978). *Functional mobility of nervous processes and professional selection*. Kiev: Naukova Dumka (in Russian).

Turovskaya, Z. G. (1963). The relation between some indices of strength and mobility of the nervous system in man. In B. M. Teplov (Ed.), *Typological features of higher nervous activity in man* (Vol. 3, pp. 248–261). Moscow: RSFSR Academy of Pedagogical Sciences (in Russian).

Umansky, L. I. (1958). Experimental study of typological features of children, nervous systems (using play material). *Voprosy Psikhologii, 4*, 184–190 (in Russian).

Unterweger, E. (1980). *Regiditaet und Reizsuche*. Unpublished doctoral dissertation, University of Graz, Graz.

Van Heck, G. L. (1987). *Temperament and coping strategies*. Unpublished manuscript.

Vyatkina, Z. N. (1976). Nervous system properties and the teacher's individual style of activity during lecture. In B. A. Vyatkin (Ed.), *Temperament and sport* (Vol. 3, pp. 99–118). Perm: MP RSFSR, PGPI & UOOP.

Watson, R. I. (1978). *The great psychologists* (4th ed.). Philadelphia: J. B. Lippincott.

Windholz, G. (1987). Pavlov as a psychologist: A reappraisal. *The Pavlovian Journal of Biological Science, 22*, 103–112.

Zarzycka, M. (1980). *Rola cech temperamentu i osobowosci w powodowaniu wypadkow przez maszynistow PKP* [The role of temperament and personality in causing accidents by engine-drivers]. Unpublished doctoral dissertation, University of Warsaw, Warsaw.

Zhorov, P. A., & Yermolayeva-Tomina, L. B. (1972). Concerning the relation between extraversion and the strength of the nervous system. In V. D. Nebylitsyn, & J. A. Gray (Eds.), *Biological bases of individual behavior* (pp. 262–268). New York: Academic Press.

Zuckerman, M. (1979). *Sensation seeking: Beyond the optimal level of arousal*. Hillsdale, NJ: Erlbaum.