Questioning the "General Arousal" Models

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Abstract: The paper argues that the concept of "general arousal", or Extraversion, which is used to present energetic aspects of behaviour is an oversimplification of the energetic components of temperament. Two reported studies were conducted on Russian and Canadian samples using the Structure of Temperament Questionnaire - Compact (STQ-77), which has 12 activity-specific temperament scales assessing various aspects of arousal separately in physical, verbal-social and intellectual activities. A selective pattern of correlations was found between STQ-77 scales and Locus of Control, Achieving Tendency, and time of performance in a prolonged concepts-classification experiment. This pattern suggests the benefits of considering at least three different types and aspects of arousal.

Keywords: "Activity-specific" model of temperament, STQ, "general arousal".

INTRODUCTION

At the beginning of the 20th century memory and intelligence were treated as undivided wholes, while today even an undergraduate psychology student understands the significance of the various subdivisions of memory and intelligence. Likewise, the concepts of Extraversion and "general arousal" should be analyzed in terms of their components and possible sub-categories. Many models of temperament and personality are based on the so-called "general arousal" theory linking the level of excitation within the nervous system with the cortical projections from the Ascending Reticular Activation System (ARAS). Overall the list of temperament traits described in about 30 various temperament models and tests reported in the literature now exceeds 80 entries, and the review of these models is not the subject of the present paper. The focus of the present report is on the flaws of "general arousal" models, which consider only one general trait related to the energetic component of behaviour, for example, "liveliness" [1], "strength of excitation" [2, 3], "extroversion" [4-6], "activity" [7, 8], Behavioural Approach System [9], "drive persistence" [10, 11] or just "arousal" [12].

At the same time it is a common knowledge that a person who, for example, exhibits an ability to sustain long and intense communication is not necessarily able to sustain long and intense physical or mental work. These observations are in line with neuroanatomical findings showing sub-specialisation of the sensori-motor cortex, and the temporal and frontal lobes in the regulation, respectively, of physical, verbal and mental activities, which might explain the consistent individual differences observed in performance of these activities. In 1980's Rusalov, working within the Pavlov-Teplov-Nebylitzyn tradition of studying strength, mobility,

lability and balance within the nervous system developed Nebylitsyn's idea to distinguish temperament traits according to the type of activity (physical versus social-verbal versus mental); in other words, the energetic and lability components are to be considered *activity-specific*. He suggested the Structure of Temperament Questionnaire (STQ), which in its Extended version assesses 4 traits: (1) ergonicity[1] (energetic component) (2) plasticity (3) tempo of activity and (4) emotionality, separately in three types of activity - physical ("object-related"), social-verbal and intellectual [13-15]. Rusalov's model was based on his studies of the consistent psychophysiological and psychological individual differences in EEG, evoked potentials, absolute thresholds in visual, auditory, and tactile modalities, strength of excitation in auditory and visual modalities, mobility in auditory and visual modalities, problem-solving in deterministic and probabilistic conditions, the speed of problem-solving using a variety of intellectual tests, time spent in attempting unsolvable problems and the number of times a subject gave up while attempting to solve a task [16]. The activity-specific model of the STQ showed consistency across four cultures [17]. The Compact version of the STQ (STQ-77) used 6 out of 12 items from each scale and rearranged and re-labelled the scales according to the traits of (1) arousal, (2) lability and (3) sensitivity in physical, social-verbal, mental areas of activity and emotionality, as shown in Fig. (**1**) [15]. Brief summary of the validation history of the Extended and Compact STQ is given in the Attachment **1**.

Studies of various physiological properties of arousal showed results in favour of the specificity of arousal, rather than the general arousal theories. Lacey [18], for example, found that arousal control of the hand, the heart, and the head had different natures. Fibiger, Singer, and Miller [19] ana-lyzed excretion of noradrenaline and adrenaline in physical and mental activities and found that the

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[1] Ergonicity is determined by endurance of activity, i.e. by how long an individual can sustain efficient performance of given tasks.

	Energetic aspect	**Lability**	**Search for/Sensitivity to**
Mental regulation	*Intellectual Ergonicity, ERI*	*Plasticity, PL*	*.. to probabilities, PRO*
Physical activity	*Motor Ergonicity, ERM*	*Motor Tempo, TMM*	*.. to sensations, SS*
Social-verbal activity	*Social Ergonicity, ERS*	*Social Tempo, TMS*	*.. to others – Empathy, EMP*
Emotionality	*Self-confidence, SLF*	*Impulsivity, IMP*	*Neuroticism, NEU*

Fig. (1). The STQ-77 structure and its temperament scales.

noradrenaline excretion discriminated well between physical and mental tests, and the different adrenergic response patterns to physical and mental effort were confirmed in real-life situations. Smit and colleagues [20] conducted EEG studies of physical and mental effort similar to Rusalov's studies. They found that the effects of mental and physical effort on vigilance are distinct: mental effort decreases vigilance, whereas physical effort increases vigilance without improving subsequent task performance. A series of studies by Rothbart [5], Derryberry and Reed [21] using children showed biological basis of mental arousal (assessed as Attention, or Effortful Control). Endurance in mental activities therefore should be differentiated from endurance in physical activities.

Previous studies using the STQ show that the arousal-related traits of temperament correlate with the personality trait described as based arousal – Extraversion - in a discriminatory manner. For example, high correlations of Extraversion, as measured by EPQ and NEO-FFI, are found with the Social Ergonicity, Social and Motor Tempo scales of the Extended STQ [13, 22-24], and with the Social Ergonicity and Impulsivity scales of the Compact STQ [25], but not with the scales of Motor or Intellectual Ergonicity. The study of gender and age differences in STQ scores also showed an impact of age-related dynamics in gender differences, which was apparent through the use of only activity-specific test of temperament. It appeared that men had higher scores on Motor Ergonicity scale, and women had higher scores on the Social Tempo scale, but such gender differences became significantly smaller after the age of 24 [26].

In the present two studies we further analysed the benefits of the differentiation of temperament traits according to the 3 different types of activity by re-examining traits commonly viewed as being based on general arousal. The goal of these studies was to find out if there is any differential pattern in the correlations between STQ-77 scales and the following measures:

- Locus of Control scale, LC, which assesses an attribution of the causes of one's own failure or success to external versus internal factors. Attribution of the causes of events in personal life to internal factors was described by Rotter as an attitude of taking responsibility and control over the events in one's life [27];

- Achieving Tendency scale, AT, which assesses a consistent and voluntary attitude to push oneself through hard work to achieve ever higher goals [12];

- efficiency of the performance on an experimental task requiring intense and prolonged verbal classification ("Semantic Task");

- the scales of another test of temperament developed within the Pavlovian tradition and using the "general arousal" approach, i.e. the scales of Strength of Excitation, Strength of Inhibition and Mobility of the Pavlovian Temperament Survey (PTS) [3].

The hypothesis of the studies is that the STQ-77 scales would correlate with these measures in an activity-specific pattern. If these stable attitudes and STQ-77 scales are based on a specific type of activation, rather than on non-specific general arousal, this specificity would argue against the validity of the "general arousal", or "extraversion" concept. We expected that:

a) the internal locus of control would have higher positive correlations with the Intellectual Ergonicity and Sensitivity to Probabilities scales of STQ-77 than with other scales. This suggestion was based on the nature of the internal locus of control, which reflects one's ability to acquire knowledge about the causes and consequences of events and to internalize responsibility for one's own actions.

b) Achieving Tendency would have higher positive correlations with the STQ-77 scales assessing the energetic aspect in physical rather than in social activity. In theory, the tendency to work very hard to achieve one's goals might be attributed to several factors. The first set of possible factors contributing to "workaholic" behaviour is of an external nature, such as a person's drive for social approval, need for social status, or adherence to social expectations and rules. If these factors are dominant, the scales related to social activity, such as Social Ergonicity and Social Tempo, would correlate with the AT scale. The second set of factors is of a more internal nature, such as biologically based temperament, abilities or potential which drive a person's need for self-actualisation. If these factors play a dominant role, then the scales assessing physical and intellectual ergonicity, not of social activity, will show the largest correlations with AT.

c) the time required for an individual to complete an intense concepts-classification task would correlate mostly with the dynamic aspects of verbal-social and intellectual activity, but not with the aspects of physical activity;

d) the Strength of Excitation scale of the Pavlovian Temperament Survey (PTS) was expected to have significant and non-differential correlations with the nine activity-related scales of STQ-77, as this PTS scale does not differentiate between arousals related to different types of activity. This scale was also expected to have less significant correlation with the time on the Semantic

Task than the STQ-77 scales measuring dynamical aspects specifically related to the verbal-social activities. It was also expected that the STQ-77 scale measuring Impulsivity will have a significant negative correlation with PTS Inhibition scale, and the "lability" group of STQ-77 scales will correlate with the PTS Mobility scale.

In general, if the pattern of correlation of STQ-77 scales with LC, AT and duration of performance in Semantic Task experiment show discrimination between the STQ-77 scales measuring the energetic aspects of different types of activity, and the PTS scales did not show differential correlation, then the activity-specific approach would be supported.

METHOD AND RESULTS

Study 1

Participants

This study, with 174 Russian participants (63 males and 111 females, aged 17-55 years, $M = 24.8$, $SD = 9.9$), volunteers (22% of the sample) and law students of the Moscow Social University (78% of the sample), was completed in 1997. Volunteers were invited during the teaching of psychology courses in the Moscow Social University and Moscow Physical-Technical Institute from students who did not need a credit, and from their relatives. Volunteers were motivated by offering to them their personal results on several psychological tests.

Measures

A. Russian versions of the STQ-77 (see description of the scales below).

B. Locus of Control Scale (LC) ([27], adapted by Bajin [28]). It has 66 items (with a forced 2-choice format, the reliability reported to be .70 and over), and describes the attribution of control over personal events to external *versus* internal factors. The items are grouped into the LC-General scale consisting of 44 items and into 6 subscales: professional area, health issues, family issues, personal relationships, success situations and failure situations.

C. Achieving Tendency Scale (AT) ([12], adapted by Sosnovsky and Orlov, [29]). It has 42 items (in Yes/No format) without any subscales. The reported reliability is over .70.

Procedure

Initially, 177 Russian subjects participated in this study by taking paper-and-pencil tests in supervised groups. All subjects went through initial debriefing and informed verbal consent. University students received a practicum credit for their participation. Three protocols, with random response pattern (for example, 12121212, or the same number repeated more than 25 times), missing items and high social desirability (as measured by the validity scale of STQ-77) were not accepted. In both studies, $r = .21$ was used as an average effect size of a correlation based on recommendation of Richard, Bond, and Stokes-Zoota [30].

Results

The scale statistics on the STQ-77R are presented in Table **1**. Each scale has a normal distribution of scores. The Achieving Tendency Scale shows the most significant positive correlations of medium effect sizes with STQ-77 scales of Motor and Intellectual Ergonicity ($d = .70$ and .63, respectively), while the Social Ergonicity scale has close to zero correlation with AT (Table **2**).

Two STQ-77 scales related to intellectual activity – Intellectual Ergonicity and Sensitivity to Probabilities—have the most significant ($d = .68$) positive correlations with the internal locus of control (as measured by the General LC scale), and the STQ-77 scales related to social activity have

Table 1. **Descriptive Scale Statistics for STQ-77R and STQ-E Scales: Means with Confidence Intervals (M_{CI}, 0.95), Standard Deviations (*SD*), Cronbach's Alpha Coefficient and Average Item-Total Correlation (M_{ITC})**

STQ Scales	Russian Sample, N=174			M_{ITC}	Canadian Sample, N=289			M_{ITC}
	M_{CI}	SD	α		M_{CI}	SD	α	
ERM	17.7 $_{16.9-18.5}$	4.9	.80	.56	15.2 $_{14.7-15.7}$	4.4	.80	.56
TMM	18.9 $_{18.3-19.6}$	4.2	.77	.51	15.3 $_{14.8-15.7}$	4.1	.76	.51
SS	17.4 $_{16.7-18.0}$	4.3	.85	.64	15.9 $_{15.6-16.3}$	3.2	.75	.50
ERS	20.1 $_{19.6-20.6}$	3.3	.77	.54	17.6 $_{17.1-18.0}$	3.7	.762	.50
TMS	17.1 $_{16.6-17.5}$	3.2	.72	.45	16.3 $_{15.9-16.7}$	3.5	.70	.43
EMP	16.5 $_{16.0-16.9}$	3.0	.71	.45	16.1 $_{15.7-16.5}$	3.4	.72	.45
ERI	14.8 $_{14.3-15.3}$	3.3	.75	.49	14.6 $_{14.1-15.0}$	3.5	.71	.45
PL	18.1 $_{17.6-18.7}$	3.6	.67	.40	15.0 $_{14.6-15.3}$	2.9	.71	.45
PRO	16.7 $_{16.2-17.3}$	3.4	.70	.44	15.8 $_{15.4-16.1}$	3.1	.70	.43
SLF	15.2 $_{14.7-15.7}$	3.4	.72	.45	15.8 $_{15.4-16.1}$	2.9	.70	.43
IMP	16.6 $_{16.1-17.0}$	3.2	.71	.44	15.3 $_{14.9-15.6}$	3.0	.71	.44
NEU	17.9 $_{17.3-18.5}$	4.0	.70	.44	15.1 $_{14.8-15.5}$	3.3	.71	.45

Note: Bold font indicates the effect sizes of $d > .80$, and italic font indicates the effect sizes of $.80 > d > .50$ for the difference between the means of 2 samples.

Table 2.   **The Correlation between the STQ-77R Scales, the Achieving Tendency Scale (AT) and the Rotter Locus of Control Scales (LC) (Russian Sample, N=174). "Gener" – LC-General Subscale, "Succ" – LC-Success, "Fail" – LC-Failure, "Prof" – LC-Professional Life, "Fam" – LC-Family, "H" – LC-Health, "Relat" – LC-Relationships**

STQ-77R Scales	AT	Locus of Control Scales						
		Gener	Succ.	Fail	Prof.	Fam	H	Relat.
Motor Ergonicity	.33***	.21**	.21**	.14	.08	.14	.02	.16
Motor Tempo	.01	.23**	.18*	.16*	.10	.10	.04	.26***
Sensitivity to sensations	-.06	.10	.07	.09	.11	.06	.13	.08
Social Ergonicity	.08	.07	.08	.08	.06	-.03	-.04	.09
Social Tempo	.23**	.17*	.13	-.01	.10	.07	.09	.09
Empathy	.14	.05	-.03	.02	.07	.00	.07	.09
Intellectual Ergonicity	.30***	.24***	.22**	.18*	.10	.23**	.15	.18*
Plasticity	.09	.16*	.19*	.07	.15	.02	.04	.13
Sensitivity to probabilities	.19**	.32***	.23**	.24***	.13	.30***	.30***	.21**
Self- confidence	.23**	.20**	.17*	.03	.18*	.17*	.08	.12
Impulsivity	-.02	.05	.00	-.03	.06	.09	.09	-.07
Neuroticism	-.01	-.05	-.05	-.08	-.11	.06	.08	.02
Achieving Tendency	1.00	.29***	.16*	.26***	.22**	.21**	.17*	.16*

*Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.*

insignificant correlations with LC scales.

Study 2

Participants

This study, with 289 Canadian participants (94 males and 195 females), aged 16-64 yrs ($M = 26.22$, $SD = 12.02$), psychology students of McMaster University, Hamilton, Ontario, Canada, (68% of the sample) and volunteers (32% of the sample), was completed during 2002-2006. The participants had a mixed cultural background, but all of them were Canadian residents with good English skills. Volunteers were invited during the teaching of psychology courses in McMaster University from students, who did not need a credit, and from their relatives, and also from visitors of Psychological Services, a private practice. The volunteers were motivated by offering to them their personal results on several psychological tests.

Measures

A. Pavlovian Temperament Survey (PTS, [3]), English version, which has 66 items grouped into 3 scales– Strength of Excitation, Strength of Inhibition and Mobility—each with 22 items. The reliability is reported to be in .81-.88 range.

B. Structure of Temperament Questionnaire, Compact (STQ-77), English version [15]. All STQ-77 versions have 77 items, assigned to 12 temperamental scales (Fig. 1, 6 items each); the Validity scale (5 items) is described below. Subjects respond following the Likert scale format: "strongly disagree (1)," "disagree (2)," "agree (3)," "strongly agree (4)". The scales are as follows:

>   1-3 – "Arousal group", the scales of Motor, Social and Intellectual Ergonicity (ERM, ERS, ERI),

assessing the ability of an individual to sustain prolonged physical, social or mental activity respectively.

>   4-6: "Lability group", the scales of Motor and Social Tempo assessing preferred speed of manipulation with physical objects (TMM) or speed of speech and reading and of other verbal activities (TMS), and Plasticity scale, PL, assessing the ability to adapt quickly to changes in situation, to change the program of action, and to shift between different tasks.

>   7-9: "Sensitivity group", the scales of Sensitivity to Sensations (SS), Empathy (EMP) and Sensitivity to Probabilities (PRO), assessing (respectively) the sensitivity of an individual to pleasures, sensation-seeking and risk-taking behaviour (SS), to another person's state and expectations (EMP), or to causes and laws of events and available knowledge (PRO).

>   10-12: "Emotionality group", the scales of Self-confidence (SLF), assessing a tendency to be optimistic and (over) confident in his or her performance; Impulsivity (IMP) as lability of emotional reaction and poor ability to control immediate impulses for actions; Neuroticism (NEU) as the expectation of a negative out-come and low tolerance of uncertainty.

C. Validity scale – assesses social desirability tendency in answers. The items of this scale describe socially undesirable actions which almost all people do, whether they admit or not. Those protocols that have values of 15-20 on the validity scale should be considered invalid as the respondents are likely to demonstrate a positive impression bias and social desirability tendency in their responses.

"Semantic Task" experiment: Participants were required to estimate 30 basic abstract concepts (words) on 60, 7-point, bipolar scales (like warm - cold, soft - hard, interesting - uninteresting, etc.). The 30 concepts are common neutral abstract words (such as "beauty", "power", "past", "future") which were chosen for their commonality to reduce the contribution of subjective experience to the resulting variance.

Procedure

Initially, 295 Canadian subjects participated in this study completing the paper-and-pencil tests in supervised groups. All subjects went through an initial debriefing and signed informed consent. Protocols with incomplete items, high social desirability (as measured by the validity scale of STQ-77) or a random response (for example, 12121212, or the same number repeated more than 25 times) on the STQ-77E, were taken out of the initial sample of 295 subjects, leaving 289 protocols for further processing. After the "paper work", each subject was invited to work with a computer in the Semantic Task experiment, using only 3 buttons: "left", "right" and "Enter". Each concept was presented on a computer monitor at the top of the screen along with each of the evaluating scales placed horizontally with 7 degrees of freedom for the cursor, which the participant used in choosing the answer by pressing "Enter". In total, 1800 concept-scale pairs were presented to each participant. Subjects were instructed to reply according to their first impression in a rather fast manner, but making sure that they read the scale and concept carefully. Their time on this task was recorded. Thirty nine subjects, mostly volunteers, either withdrew from the experiment, stopped midway, or the time of their performance was not recorded carefully. Nine records with random or inconsistent answers were detected by the computer program (Expan), only 247

protocols were accepted out of 256 completed. University students received a practicum credit for their participation.

Results

The scale statistics for the STQ-77 are presented in Table **1**. Each scale has a normal distribution of scores. The analysis of the difference between the means of 2 samples shows that the means of the Russian sample on Motor Tempo and Plasticity are higher than those of the Canadian sample with high effect size ($d > .80$), and medium effect sizes are found for Motor and Social Ergonicity and Neuroticism scales.

During the "Semantic Task" experiments, it took between 37 minutes and more than 3 hours for subjects to complete the task with an average of 1 hour and 21 min. ($SD = 26.7$ min.). The duration of performance on the "Semantic task" showed a significant negative correlation with the Social Ergonicity and Sensitivity to Sensations scales (both $d = .43$). Higher scores on these scales are associated with a shorter time needed for the subjects to complete the task (Table **3**).

The correlation between the Pavlovian Temperament Survey and time of performance on the Semantic Task (TSem) showed a small effect size for the scale of Strength of Excitation, but no significant correlations between TSem and other two PTS scales.

The highest positive correlation of the PTS Strength of Excitation scale is with the STQ-77 scale Sensitivity to Sensations ($d = 1.50$), followed by Motor Tempo and Social Ergonicity (both having $d = .82$). The highest (positive) correlations of the PTS Mobility scale are with the STQ-77 scales of Plasticity and Social Ergonicity (both having $d > .90$). Overall, however, the PTS scales of Excitation and Mobility have many medium-size effects in positive

Table 3.   **The Correlation between the STQ-77E Scales, Time of Performing "Semantic Task" (SemT), N=247, and Pavlovian Temperament Survey Scales: Strength of Excitation (PTS-E), Strength of Inhibition (PTS-I), and Mobility (PTS-M), N=289**

STQ-77E Scales	SemT	PTS-E	PTS-I	PTS-M
Motor Ergonicity	-.06	.30***	.01	.21***
Motor Tempo	-.08	.38***	-.05	.32***
Sensitivity to sensations	-.21***	.60***	-.05	.34***
Social Ergonicity	-.21***	.38***	-.06	.44***
Social Tempo	-.15*	.35***	-.13*	.33***
Empathy, sensitivity to others	-.18**	-.10	-.27***	-.09
Intellectual Ergonicity	.13*	.05	.12	.06
Plasticity	.00	.32***	.06	.42***
Sensitivity to probabilities	.06	.23***	.20**	.31***
Self- confidence	.01	.22***	.10	.25***
Impulsivity	-.15*	.07	-.57***	.08
Neuroticism	-.05	-.16**	-.06	-.31***
PTS-E	-.16**	1.0	.06	.45***

*Note: * p < .05, **p < .01, *** p < .001*

correlations with STQ-77E scales. Six out of nine STQ-77 scales assessing activity aspects (related to Ergonicity), Tempo and Sensitivity (with the exception of Intellectual Ergonicity and Empathy) have medium and high effects of correlation with the PTS "general arousal" measures, i.e. with its Strength of Excitation and Mobility scales (Table **3**).

The Impulsivity scale of the STQ-77E correlates negatively with the Strength of Inhibition scale of the PTS showing high effect size ($d = 1.39$). It confirms the content of the Impulsivity scale of the STQ-77 as reflecting the inability of a person to inhibit direct and immediate reactions. At the same time, the scale of Sensitivity to Sensations, which describes risk-seeking behaviour often viewed as disinhibition, shows no significant correlation with the PTS-Inhibition scale. Instead, the STQ-77 scale of Sensitivity to Sensations has the highest correlation with the PTS-Excitation scale, confirming Zuckerman's hypothesis about the existence of a high level of arousal in sensation-seeking people [31]. This pattern of correlation indicates good discriminant validity for the Impulsivity and Sensitivity to Sensations scales of the STQ-77.

DISCUSSION

Linking complex behavioural attitudes or personality traits to the dynamical properties of the nervous system should be done with great care, and it is here that the activity-specific approach to the components of temperament might prove beneficial. The results of this study show that Achieving Tendency can be linked to physical and mental arousal, but not to arousal in social-verbal performance. Locus of Control in this study (which reflects the ability of a person to anticipate the outcomes of events and their own actions in advance) appears to be linked primarily to mental activity, as assessed by the Intellectual Ergonicity and Sensitivity to Probabilities scales of the STQ-77, and not so much to the dynamical aspects of the physical or social abilities of a person. The verbal classification task was performed faster and more efficiently by people with higher Social Ergonicity ($r = -.21$, which is an average correlation value in meta-analytic studies [30]), i.e., with higher arousal in social-verbal activity, but not in the other two types of activity. This demonstrates that the componential analysis of the temperament traits underlying stable and consistent behaviour helps one in carrying out a detailed mapping of the traits at several levels of individuality. Such differential analysis would not be possible with "general arousal" approaches. It is interesting to see that while it is common to associate motivation for achievements and attribution of responsibility with the social development and personal history of an individual, the dynamical aspects of social activity (arousal and sensitivity aspects) do not appear to correlate with either AT or LC.

The multiple correlations of the PTS Excitation and Mobility scales with the STQ-77 scales provide an example of how a "general excitation" model does not differentiate between several distinct aspects of arousal. Such a non-specific pattern of correlations between the activity-related scales of the English STQ-77 and the PTS is similar to those reported by Strelau based on Polish and German samples [3], by Ruch and colleagues based on a German sample [32], and

by Trofimova based on a Canadian sample [33]. In these studies, the Excitation and Mobility scales of the PTS were also highly positively correlated with all activity-related scales of the STQ, and negatively with the Social Emotionality scale of the STQ. The division of temperament traits into arousal-driven and inhibition-driven processes might have some validity, but it overlooks those aspects of arousal which are specific for humans. While Pavlov, in his original experiments on dogs, could not observe social or intellectual types of activities and therefore limited his theory to three traits (i.e. strength of excitation, mobility and balance) regulating the behaviour of an animal, these activities are clearly identifiable in humans and should be treated with care. The activity-specific approach of the STQ is, in this sense, more sensitive to the dynamic aspects of per-formance in both physical activity and human-specific social and mental activities.

In summary, the selective pattern of correlations observed here supported our hypothesis about the differential impact of three types of arousal on consistent behavioural attitudes and on performance in the concepts-classification task. These results complement previous studies showing that Extraversion is related to specific arousal in social activities, and not so much in intellectual or physical activities.

Some final remarks are due regarding the coupling of psychological traits. It appears that psychological characteristics possess a hierarchical and bifurcation structure that might not be observed by factor analytic studies searching for "clearly independent" traits. For example, Mobility as measured by the PTS, shows correlations with both Ergonicity (power of arousal) and lability of the arousal scales of STQ-77E. This may be due to the coupled nature of lability and arousal, which has been noticed since Pavlov's time. Pavlov classified nervous systems into weak and strong types, and differentiated only the strong types by the mobility criterion. The high effect size ($d = 1.01$) of correlation between PTS Excitation and Mobility scales indicates such a coupling, which might render differentiation between power and lability of arousal difficult in either of the PTS and STQ-77E scales. The nonlinear relationship between psychological traits was missed in the "general arousal" theories and caused serious difficulties in differentiating the traits. Thus, Revelle and colleagues [34] and Fahrenberg [35] noted a coupling of arousal and lability of emotion (impulsivity) in Eysenck's concept of extraversion and suggested that these two dynamical aspects should be operationalized differently.

The second example is the coupling of the correlations between the AT and LC-General scales, which is significant at $d = .61$. Judging by the results of "componential" analysis using the STQ-77, this is not surprising, as both AT and LC correlate significantly with the Intellectual Ergonicity scale, i.e., with the ability of a person to sustain prolonged and/or intense mental activity—a trait that forms one of the necessary components of AT and LC. Medium effect sizes of these correlations may reflect the fact that many other factors, possibly of a social nature, contribute to Achieving Tendency and Locus of Control.

The third example of coupling is that between "executive" traits and "sensory" or attributional traits. The correlation of the STQ-77R Motor and Intellectual Ergonicity scales

with the Achieving Tendency Scale (AT) is consistent with the description of AT as the tendency for a higher aspiration level, and an ability and attitude to work harder to achieve higher goals. The correlations of the AT scale with the Motor and Intellectual Ergonicity, Sensitivity to Probability, and Self-confidence scales of the STQ-77, as well as the abovementioned correlations between the STQ-77 and LC scales, suggest an *internal* nature, i.e., abilities and temperament, which mostly push an individual to set personal goals and to work hard to achieve them. This would explain the situation in which a workaholic complains thus: "I know I am crazy to have these goals and to work like this, but I can't stop myself." It is in line with an idea of Schore [36] that the "inner world" of an individual is more than cognitions and includes the realm of bodily processes, the central components of emotional states. Correlation of energetic capacity with the aspirations of an individual also supports the hypothesis of "projection through capacities", proposed by Trofimova [37], which suggests that a person perceives and organizes his or her life based mostly on internal capacities rather than on external requirements and expectations.

The differentiating pattern of correlations also demonstrates that complex human behaviour might be regulated by more than 3 or 5 biologically based traits presented in the "general arousal" theories. Coupling of several traits, such as impulsivity, sensitivity and sociability in Eysenck's concepts of arousal and extraversion was noted by Revelle [34], Fahrenberg [35], Farthofer and Brandstatter [38], O'Gorman and Lloyd [39], Matthews and Gilliland [40], Schore [36] and others. Nigg [41] showed the benefits of multi-component presentation of temperament linking psychopathology to extreme temperament types.

The coupling nature of temperament traits related to arousal, and also differences in arousal related to at least three types of activity, questions the "general arousal" models received in factor-analysis. The independence of dimensions received in factor-analytic studies might be a very convenient property in physics and mathematics, but it might not be suitable for the description of the psychological phenomena, unless we are looking at an oversimplified picture. It seems that the presentation of the complex human physiology of individual differences using just two or three "general" or "universal" labels might be an example of such simplification.

The current studies have several limitations. The STQ-77 and the other 3 tests used in this study are self-report measures and have limitations common for such measures: an impact of social desirability, distorted self-perception or misinterpretation of the test statements. To reduce the factors interfering with the validity of the results the samples were screened for sufficient intellectual and educational level of participants. The STQ-77 validity scale and a computer program, which allowed one to screen for a high social desirability tendency and to select invalid protocols, improved the validity of results but did not completely eliminate the measurement errors expected in self-reports. The experimental part of the study investigated the content of only a few STQ-77 scales. Despite the rich history of the experimental and concurrent validation of the STQ, this study cannot be the basis for a final conclusion on several types of validity of all

the 12 scales of STQ-77. Further studies are needed to complement the findings reported in this article.

SUPPLEMENTARY MATERIAL

Supplementary material is available on the publishers Web site along with the published article.

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