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PREFACE

Dear colleagues,

We are pleased to welcome you in Moscow – one of the leading psychological centers of the Russian Federation!

In the 19th and 20th centuries the famous psychological schools were founded in Moscow. Their development was closely connected with the Russian Psychological Society founded more than 135 years ago and the Psychological institute (one of the first in the world) founded about 100 years ago. Fifty years ago the 1st Psychology Department was opened in Russia – in Lomonosov Moscow State University, where Fechner Day'2016 is being held in this jubilee year.

The principal trends of modern psychology are associated with such Russian psychologists and physiologists as I. P. Pavlov, V. M. Bekhterev, G. I. Chelpanov, V. A. Wagner, L. S. Vygotsky, A. N. Leontiev, B. G. Ananiev, A. R. Luria, B. V. Zeigarnik, S. L. Rubinstein, Ye. N. Sokolov. They are the direct or indirect disciples of W. Wundt, P. Natorp, J. M. Charcot, K. Lewin and other founders of the European psychology. The famous schools in the field of neuroscience are developing in Russia as well – they are schools of L. A. Orbeli, A. N. Bernstein and P. K. Anokhin. It is exactly the outstanding works of the above-mentioned Russian scientists that have become the basis of the modern Russian psychophysics.

We would like to particularly mention our teachers in the field of psychophysics: Ye. N. Sokolov, Yu. M. Zabrodin, K. V. Bardin, M. B. Mikhalevskaya, I. A. Indlin, Ch. A. Izmaylov. In the 1950–1990s they really built the Russian psychophysics, which gained momentum at that time. They assisted for the intensive international cooperation between psychophysicists. Two books were published at that time which reflected this cooperation:

1. *Advances in Psychophysics*. H.-G. Geissler, Yu. M. Zabrodin (Eds). VEB Deutscher Verlag der Wissenschaften, Berlin, 1976.
2. *Psychophysical Judgments and the Process of Perception*. H.-G. Geissler, P. Petzold (Eds). VEB Deutscher Verlag der Wissenschaften, Berlin, 1982.

Besides the papers of the editors and of the Russian psychophysicists mentioned, these books include the papers of many famous authors: J. Swets, R. Luce, H. Eisler, F. Klix, N. Anderson and a lot of others.

You know the disciples of our teachers mentioned, who currently work in the world's leading universities: E. Dzhafarov, G. Paramei, A. Logvinenko, M. Pavlova, A. Sokolov and others.

There are a lot of students who study at more than 50 Psychology Departments in Moscow. They are our Future. We hope they will become top-level professionals in the fields of Psychophysics and Neuroscience. For this purpose the subject *Psychophysics* is included as a mandatory topic in the Russian Federal State Educational Standard.

For the 32 years of ISP existence, 31 annual meetings have been held. In 2016 Fechner Day is organized in Russia for the first time, which has been looked forward to by ISP members for several years. So it is a unique event for the Russian science and we are trying to hold the Meeting at such a high scientific level as it has always been in ISP history. It seems to be the most important event at present time, especially since the international climate is so complicated. The Russian psychologists have a deep belief that political problems will not be an obstacle for international scientific contacts and that such contacts are necessary for strengthening peace in the world as well as for scientific development. We cordially thank our foreign colleagues for their participation in the Meeting.

In the Fechner Day'2016 program a number of Theme Sessions were formed. First of all, we would like to underline the talks reflecting the developing theoretical conceptions. In the Theme Session *"Extending Traditional Psychophysics"* rather new theoretical approaches are presented, which are not traditional for psychophysics but help to extend its borders. It seems to be necessary for contemporary psychophysics to study not only "pure sensations" and "an ideal observer" but a real observer's performance in sensory tasks (his (her) activity, attitudes, individual peculiarities), and to increase the studies of applied problems as well.

In some talks included into the Theme Session *"Developmental and Animal Psychophysics"* one of the main psychological problems are elucidated: about the origin of Mind and the criterion of the appearance of Mind in the course of evolution. The talks concerning these problems are included into our program since sensory sensitivity appearance was suggested to be that criterion in A. N. Leontiev's "Theory of the Development of Mind". Of course, talks on animals' and children's psychophysics are presented in this Session.

Other Theme Sessions are: *Sensory Measurements, Decision Making and Confidence in Sensory Tasks, Cognitive* (*Memory, Attention, etc.*) *and Emotional Factors in Perception and Psychophysics, Psychophysics and Neuroscience, Free Talks.* All of them are quite typical for Fechner Days and include a variety of psychophysical topics.

We are very pleased that Fechner Day'2016 takes place in Moscow. From our point of view, the Meeting may be considered as a real support to the development of modern psychophysical research and new

methods and procedures as well, which are currently becoming increasingly important for the development of Psychophysics and Neuroscience.

We would like to thank those organizations that have supported the Meeting: the Russian Foundation for Basic Research, the Russian Foundation for Humanities, ISP Executive Committee, Lomonosov Moscow State University and the Institute of Psychology RAS.

Let us look into the mirror of modern psychophysics, see our reflection, remember our teachers and receive a positive feedback, as psychophysicist say.

We hope that our joint work will be fruitful and successful. We also believe that our guests will enjoy the sights of Moscow and the hospitality of Moscovites.

Irina Skotnikova,
Alexey Gusev,
Galina Menshikova

INVITED LECTURES

Theory of measurement of invisible mental phenomena

Stephen W. Link*
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Fechner's creation of the theory of comparative judgment stands as a milestone in scientific progress. The theory demonstrates how two Gaussian representations of sensations are used to create a decision threshold for choosing which of two stimuli is either larger, or smaller, or either heavier, or lighter, or either brighter, or dimmer, and so on. Today the simplest form the theory is called Ideal Observer Theory. No one gave Fechner the credit for inventing it nearly a hundred years before. Yet the theory is the basis for experimental psychology and also is the basis for statistical hypothesis testing.

Fechner's many experiments applied the theory to measure the mental ability to discriminate between two stimuli. He provided various measures of discrimination as well as measurements of the variance of neural signals used to make discrimination. Thousands of experimental trials led Fechner to suggest that the process of discriminating between two stimuli resulted in a *constant error*. "When the method of right and wrong cases is used in weight-lifting experiments, the *constant error* is demonstrated when a large number of cases where the container with the comparison weight is lifted first is compared against an equally large number of cases where it was lifted second. The ratio of right to wrong cases in one instance will be quite different from the ratio in the other".[1]

Later, Urban expanded psychophysical methods for analyzing comparative judgments by creating the method of just perceptible differences and the Psychometric Function[2] Although Urban refined the method of plotting response proportions as a function of comparative difference, no underlying causative theory predicted the form of the results so often obtained. Yet the theory first created by Fechner is one theoretical basis for the results discovered Urban and many others.

A perfect example of both the *constant error* and the Psychometric Function appears in an experiment on judgments of brightness. Kellogg's[3] 1931 experimental results conform to predictions of Link's sequential theory of relative judgment[4]. The theory predicts the form of the Psychometric Function, provides a measure of the *constant error* in units of the physical stimuli and accounts for response times measured by Kellogg without his Observers' knowledge.

Relative judgment theory moves a step forward by predicting response proportions, response times and relations between these two commonly measured performance variables. Although the developing theory owed much to Mathematical Biophysics[5] and the characterization of neural signals as Poisson transmissions[6] a new theory of the Ideal provides a measure of the Ideal age for marriage and a view of female facial attractiveness.

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From physics and psychophysics to contemporary NBICS-synthesis: Scientific psychology in the North-East of Europe

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Ever since Galileo measurement was the key element of any scientific research. This prototype methodology of physics was transferred by Fechner, Helmholtz, Wundt, Dubois-Reymond and other pioneers to investigation in psychophysics, psychology and physiology. In the talk I shortly overview evolution of this paradigm in the works of Russian scientists starting with Sechenov, Bechterev, Pavlov and continuing with such classics of the 20th Century psychology as Luria, Vygotsky, Leontiev and Sokolov.

The main part of my talk is devoted to a new paradigm of research in mind-and-brain domain, which demonstrates an unprecedented convergence of methods from Nano-, Bio-, Information-, Cognitive- and Social sciences. Several recent lines of studies on consciousness and its material basis from Kurchatov Institute exampling such NBICS-paradigm will be described. One of these lines of research focuses on development of a new class of interfaces between human operators and technical devices, the Eye-Brain-Computer Interfaces[2]. The crucial aspect of this research is a solution of the classical Midas Touch Problem, namely a fast automatic differentiation of reflectory and reflective (voluntary) eye movements.

My next example is a study of causal (effective) relationships within the default mode network (DMN) as represented by its major structures: the medial prefrontal cortex (MPFC), posterior cingulate (PCC), the inferior parietal cortex of both hemispheres (LIPC and RIPC), as well as the left and right hippocampal regions (LHIP and RHIP, respectively). These areas of the brain are activated in a resting state and deactivated by external stimulation or cognitively effortful tasks. Hypotheses on functionality of the DMN mostly relate it to higher-order aspects of consciousness and cognition[5,6]. In our experiments we also tested stability of the connectivity patterns when adding or deleting regions of interest. The fMRI data from a group of 30 healthy subjects in the resting state were collected and submitted to analysis of structural, functional and effective connectivity. To model the effective connectivity we used the spectral Dynamic Causal Modeling (DCM). Three DCMs were completed. Two of them modeled interaction between five nodes including four DMN key structures with addition of either LHIP or RHIP. The last DCM modeled interactions of four nodes whereby one of the main DMN structures, PCC, was excluded from the analysis. Results of all DCMs testified to a high level of computational stability: those parts of the winning models that included the major DMN structures demonstrated causal relations known from our earlier research[1]. However new results have been discovered as well, first of all a pronounced asymmetry in LHIP and RHIP connections. The LHIP demonstrated a high involvement in the DMN activity with information outflow preponderance to all other DMN regions. The only exclusion was LIPC which causal interaction with the LHIP was bidirectional. On the contrary, the RHIP was mainly affected by inputs from LIPC and RIPC. For the first time an inhibitory link was found from MPFC to LIPC, which may indicate the subjects' behavior setting to maintain resting state. Overall, the DMN can be considered as an optimally tuned system of operational rest. The only drawback of such lateralized architecture is its vulnerability to unilateral destruction of the RHIP (but not LHIP) leading to the multimodal left-sided spatial hemi-neglect. This is exactly the phenomenon well-known from observations on a large number of right-handed patients with unilateral brain damages[3,4].

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EXTENDING TRADITIONAL PSYCHOPHYSICS

An approach to solve a problem: whether a sensory threshold really exists

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A classical psychophysical problem is not solved yet: whether a sensory threshold really exists. A variety of empirical ROC points does not allow to approximate them by one concrete theoretical ROC and therefore to prefer a correspondent theory which implies the threshold existing or denies it[1]. Two conceptions which described two successive thresholds suggest different solutions of this dilemma.

1. Theory of low threshold which is localized in an area of a sensory system own noise. A decision making criterion which is localized above it, performs a function of the 2nd threshold[2]. The theory is well known in the world psychophysical literature.
2. In distinction another conception is known in Russian psychophysics mainly.

a) It develops an orienting reflex paradigm[3]. A threshold of a *local orienting reaction* performs a 1st threshold function. An activation (or an arousal ability) of a sensory system increases due to this reaction, in conditions of sensory information deficit in detection and discrimination tasks. Such a threshold is registered objectively by a stable α-rhythm depression reaction in distinction of Swets' low threshold. And a decision making criterion performs a 2nd threshold (a threshold of a conscious response) function[4] as well as it is in 1. A latent response time (LRT) of the 1st – unconscious physiological reaction was lower than a LRT of the 2nd conscious motor response. The both thresholds existing was revealed on the base of regular differences in the both reactions psychometric curves and confirmed by a computer simulation[5]. The curve for the 1st one was normal while that for the 2nd one had the left-side asymmetry being a possible sum of the 2 successive information processing stages: unconscious and conscious ones. Note: in order to estimate the 1st threshold value, α-rhythm depression registration is possible in case when the decision making criterion is high. But along with the criterion decrease, an observer's functional state changes and α-rhythm is transformed into β-rhythm. It may be caused by additional activation resources appearing during the criterion decrease.
b) Besides, a theoretical conception was worked out which suggested to estimate not threshold points but *a threshold range* in which a "yes"-response probability changed from 0 to 1 and which exists objectively[5] in distinction of a threshold as a point at a sensory axis.

On the base of a number of data obtained it was suggested to localize the threshold in 1 of the 3 axes: sensory, decision making or response one[1].

The idea has not lost it's relevance and is confirmed by modern data[7,8].

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Psychophysics of perceived quality

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We introduced the concept of perceived quality when using psychophysical methodology to investigate the perception of complex objects and events being a part of natural human environment and daily life situations[1,2,3].

The perceived quality approach proposes an analysis based on the general idea that it is not always the best strategy to define a priori a set of the so called "objective" parameters of the object under study (size, form, speed, etc.). The characteristics of the object actually significant for the subject should be identified initially.

According to the classical paradigm of investigation a researcher begins with creating a "physical model" of the object and tries to reveal the relationships that might exist between its features and their perceptions. However, sometimes it turns out to be difficult to reveal a direct relationship between certain parameters of a complex object and its subjective perception and evaluation as a whole. Real life situations are hard to inscribe into the classical experimental design with the operationalization of dependent and independent variables. It is difficult to establish in advance the whole set of parameters that a subject is going to perceive in an object or an event. Besides, the relationship between the parameters and the perceived quality may be indirect, and mediated by multiple factors.

By contrast, the perceived quality approach starts with identifying the aspects of an object or an event that are subjectively valuable for a certain individual in the course of certain activity. The approach implies that these aspects will be included into the perceived quality, and sets up a measurement system based on them as they appear in open ended individual verbal evaluations (e. g. "useful", "fast", "clear", "difficult"…).

Following S. L. Rubinstein's opinion, we consider subjective and objective phenomena as different aspects of psychic reality rather than as oppositions[4]. It means that the perceived quality of an "objectively" measured event has its subjective components "objectively" manifested as well. The subjective components can be identified, measured and interpreted using research methods that ensure the "objectivity" of the study.

A key method to make an analysis easier is to use a comparison process, where a subject is asked to identify similarities and differences in several objects (events, situations) related to the same activity[6]. In this case, peculiarities of interaction with the objects can be easily matched with the differences in evaluations. Multi-positional observation techniques aimed at nonverbal behavior and context analysis are to be used as well. The perceived quality paradigm allows both quantitative and qualitative analysis of those complex perceived events which are usually only qualitatively investigated. The efficiency of this approach has already been demonstrated in studies dealing with human perception and in those regarding different human activities[5,3,7].

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Subject-oriented psychophysics of sensory tasks

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In the frame of traditional psychophysics quantitative relations are examined between external factors used and responses indices obtained in sensory measurements. Hence, facts were cumulated which showed the indices changes in dependence of subject's variables. Their significance is mentioned at present (see[1,2,3] and references there in).

Subject-oriented psychophysics of sensory tasks[1,3] considers such facts to be principal ones (but not artifacts) and adds a new research approach to the traditional paradigm. An observer's behavior in psychophysical measurements is considered as sensory tasks solving. Two versions of this approach differ by theoretical accents only. One version develops A. N. Leontyev's paradigm which considers a person's behavior to be his/her object activity directed to the person's task fulfillment[4]. Therefore an accent is put to the task given[3]. The other version develops the same paradigm united with S. L. Rubinstein's one which treats a person as an active author initiating his (her) object activity and behavior[5]. Therefore an accent is put to the person him(her)self who accepts the task given or transforms it to some extent according to his/her attitudes, individual features and inner states[1].

The main characteristics of this task are: stimuli (or their differences) low values; random order and high (and often forced) temp of stimuli presentation used as a rule, which cause high information loading to an observer; his/her limited mobility[3].

Hierarchical structure of a participant's activity has been revealed which appears to be an internal determinant of results obtained. This system components has been found as following: a task as it has been accepted by an observer, his/her inner states (activation, effort, confidence–unconfidence), individual peculiarities (cognitive styles, extroversion–introversion, neurotism–emotional stability), strategies used which are determined by the task from one hand and individual peculiarities from the other hand. These components has been revealed experimentally in sensory tasks of signal detection and discrimination, where intensities of visual (brightness) and auditory (loudness) stimuli have been used as well as visual temporal (durations) and spatial (line length) stimuli (i. e. prothetic and metathetic stimuli) in the course of their simultaneous and successive presentation[1,3].

New data obtained (in press) show the following. A confidence level decrease was revealed along with payoffs increase for erroneous responses in visual durations discrimination. The confidence level was found the same as registered in this task and in facial emotional expressions discrimination, i. e. for simple sensory stimuli which are indifferent for an observer and for complicated pictures which are significant for him/her ecologically. Including certain information into a feedback given to the observer allowed to obtain a greater decrease of typical confidence bias (overconfidence, underconfidence) than before (Skotnikova's et al. data).

Cognitive styles, motivation-, will- and self-regulating-caused effects were revealed which determined strategies used by observers in order to solve sensory tasks characterized by great information loading. Theoretical usefulness of a "functional organ" concept (according to A. Ukhtomskii – see[3] for the references) was shown, which allowed to provide a systematic analyses of observers' activity during sensory tasks solving (Gusev's et al. data).

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Psychophysics of a generalized image

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Traditionally Psychophysics deals with the solution of the main task – the interaction of Mind and the external world. The result of this interaction is a mental image of the world. Usually studied sensory images represent separate properties of the object, but not it's image as a whole.

A generalized image represents the basic structure of the holistic system of the Mind, which reflects the dynamics of a real, objective world in the process of continuous interaction with him. *Activity, integrity* and *dynamics* are basic properties of the generalized image[1].

Activity is expressed primarily as a choice of system goals that ensure an existence of systems and setting targets to achieve them. An aim selection is a basis for a forecast of a planned future. It manifests itself in a continuous process of forming hypotheses about a possible change of a situation, which is usually confirmed due to the stability of the surrounding world and a person's ability to anticipate an emergence of emotionally-significant events.

Under the *integrity* of the Mind and, accordingly, a generalized image, we understand, first of all, an equality of the system elements, the relationship between them is built on the coordination principle. Depending on specific activities, especially in the psychological laboratory, these elements may form dynamic hierarchical structures that is disintegrated when you change activities.

Integrity is not introduced in the generalized image of any "higher mental formations", but inherent to it. But the integrity of the generalized image and integrity of the objective world differ fundamentally. The integrity of the world is the superposition of its components, which consists of "elementary bricks of the universe". The integrity of the generalized image exists initial. "Elementary units of Mind" are extracted from the integral image by secondary analysis, which has been made according to the task.

Dynamics of the generalized image is expressed in it's continuous change, in the process of continuous interaction with the outside world. The interaction between Mind and an object is expressed in changing of the mental image of the object, i. e. a result of an interaction is not the image by itself, but it's changing in the process of interaction. This activity of the generalized image leads to a continuous process of its self-formation.

A relative constancy of the external environment determines an existence of a component which has sufficient inertia in the dynamics of the generalized image. This component generates a perceptual hypothesis, which finds their confirmation in practice as a rule. A structure of the generalized image can be expressed as a series, which terms in inertia decrease when accommodation is growing, and sensitivity increases to environmental changes. For example, an effect of the first members of a series is evident in people stereotypical reactions to everyday familiar situations; the members of the series having very high rooms are responsible for responses to micro-damage of a body position and participate in the organization of the levels of movement construction.

Activity, integrity and *dynamics* being basic properties of generalized image cannot be independent in any sense, even in statistics. These properties are derived one from the other. Integrity, like the integrity of the mental formations cannot be active, and activity, in turn, manifests itself in the dynamics.

The generalized image, being an active subjective movement model of the objective world, fundamentally cannot be complete, especially to be identical reflection of its object. The model always has quite strong disagreement with it's subject that seems to be one of the sources of development. A difference between the object and the model is not simply a consequence of the mediated model-building, but also the fundamental condition of existence of a subject of the activity. The concept of "generalized image" does not just declare the integrity of Mind but offers a new additional subject of Psychophysics. The provisions of this concept was verified in four series of experiments that demonstrated it's validity. The idea is to reject the rigid hierarchy of the structure of Mind, in the view of its approximate models in the form of a dynamic psychological system that is continuously changing according to context changes.

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SENSORY MEASUREMENTS

Measuring loudness constancy using the Category Partitioning procedure

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Loudness constancy describes the tendency to perceive sounds as equally loud regardless of the listeners distance to the sound source. Thus experienced loudness is determined by the sound pressure at the ear drum and the perceived distance to its source. Commonly perceptual constancy is quantified using classical Fechnarian techniques like forced choice or the method of adjustment (instruction: "adjust the amplitude of a sound source near to your ears until it sounds as loud as a sound generated by a distant source").

Category Scalings, in contrast, are considered to be less precise and influenced by various contexts. That's why they are rarely, if ever, used to study perceptual constancy. Hellerr's orientation-approach, however, predicts that data obtained by category scales are valid representations of perceived phenomena, if the measurement regulations conjoined with the Category Partitioning procedure (CP) are taken into account[1].

This was verified by a group of n=139 students who at the same time scaled the loudness of white noise at sound pressures of 30, 40, 50, 60, 70, 80 or 90 dB (SPL) as measured at a distance of one meter to the sound source. Participants were seated in the main lecture hall at distances between 1m and 18m to the loudspeaker, resulting in a difference of sound pressure of 17.8 dB. The stimuli where presented in irregular order for 2×2 seconds with a pause of 2 sec in-between. The instruction was: "You will hear different sounds. Please describe their loudness by using the CP-scale". The series of sounds were repeated twice but in different order and not noticeable for the participants.

The results as given in the upper chart of Fig. 1 show nearly perfect constancy. Suspicious, however, that the loudness scaled increased with repetitions. As it could not be ruled out, that range effects mimic constancy, care was taken in the analysis of data and further experiments were performed leading to changes in the presentation order of the stimuli. The lower chart in Fig. 1 shows results of a similar experiment with another cohort of n=125 participants, with the only difference to the first experiment, that the order of stimulus presentation was reversed. The results confirm that the scaling procedure applied is suitable to represent the situation-specific perception of sounds.

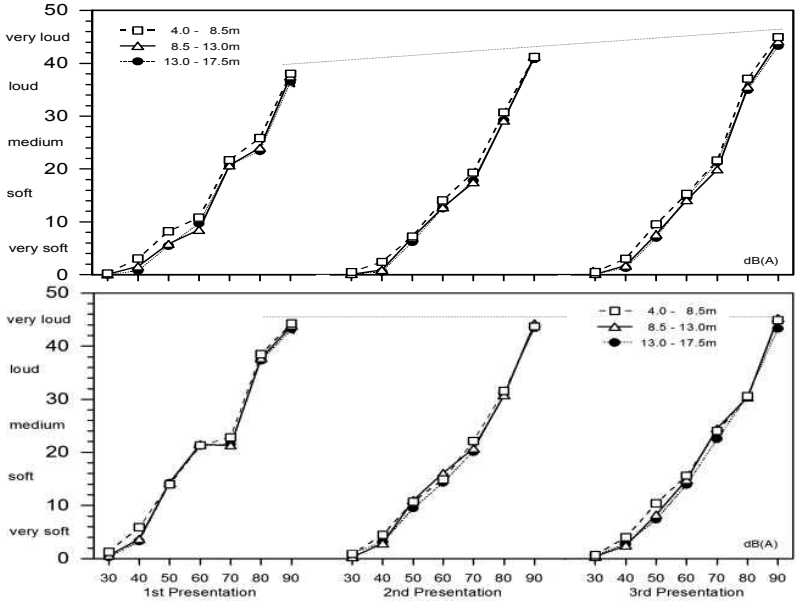

Fig. 1. CP-loudness for white noise as perceived at different distances to the sound source. Participants were not aware, that a series of 7 stimuli was presented 3 times but in a different order. Upper graph: 1st experiment (n=139); Lower graph: 2nd experiment (n=125) with the stimulus presentations reversed

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The psychophysics of comparison at a distance: the case of motion

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A neglected but challenging psychophysical issue is that of how targets are compared when they fall at different, widely separated, positions in the visual field[1,2]. We have previously shown that thresholds for discrimination of spatial frequency are similar whether targets are juxtaposed or are separated by up to 10 degrees of visual angle (eccentricity being held constant) – and even if the targets fall in opposite hemifields[3].

In the present experiments, we measured thresholds for comparing speed in two concurrently presented patches of random moving dots. The stimulus patches lay on an imaginary circle of 5 degrees radius centered on the fixation point, and their presentations were too brief to allow eye movements between them. Their spatial separation varied from zero to 10 degrees. The direction of motion was the same in both patches and on any given trial was chosen randomly to be horizontally leftward or horizontally rightward. The discrimination of speed was measured by a two-alternative forced choice: one of the patches, chosen randomly, consisted of red dots and the other consisted of green dots, and the observers' task was to indicate which set of dots was moving faster. To ensure that the observer actively compared the two patches – rather than comparing one target to an internal template or criterion[4] – we jittered the speed of the reference patch on any given trial.

Under our conditions, the Weber fraction for discriminating speed was between 10% and 20% and varied little across different separations. In this last respect, the discrimination of speed resembles the discrimination of spatial frequency and differs from the discrimination of luminance or stereoscopic disparity. The latter discriminations deteriorate rapidly with spatial separation and are thought to depend on local comparators[5,6]. If discrimination does not deteriorate at large separations, as is the case for spatial frequency and for speed, then it is implausible that performance depends on dedicated 'comparator neurons', i. e. higher-order cells which would draw inputs from pairs of lower-order cells that signaled speed in local retinal regions. Calculation suggests that a battery of such comparators, for every possible pair of positions in the field and every stimulus attribute, would require an unlikely bulk of neurons and white matter. We postulate instead a 'cerebral bus'[3] that carries abstract representations of separated stimuli.

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The metathetic and prothetic dimensions of colour have different thresholds

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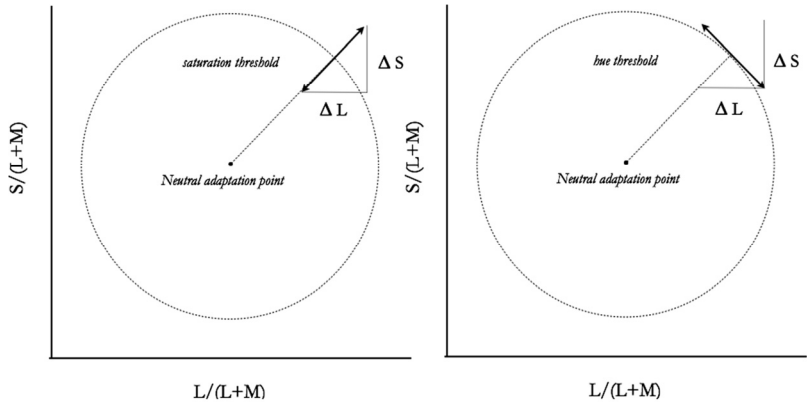
In the classification of S.S. Stevens, hue is a metathetic dimension, in that it consists in variations in sensory quality; and saturation is a prothetic dimension, in that it consists in variations in the strength of a particular quality[1,2]. However, the two types of dimension are seldom explicitly compared in studies of chromatic discrimination.

To compare directly the two types of threshold, it is necessary to have a common metric. To solve this problem, we compared thresholds for the two dimensions under conditions where the only difference between hue trials and saturation trials was the phase with which the signal of the short-wave cones was combined with the signals of the long- and middle-wave cones. We worked within the framework of the MacLeod–Boynton chromaticity diagram[3]: the abscissa of the diagram is $L/(L+M)$ and the ordinate is $S/(L+M)$, where L, M, S are the excitations of the long-, middle- and short-wavelength cones respectively (see Figure below). These 'cardinal' axes of colour space[4] are thought to correspond to the two primary chromatic channels in the early stages of the visual system.



We made measurements at reference points lying on lines that passed at either 45° or –45° through the chromaticity of the neutral background (which was metameric to CIE Illuminant D65). The vertical (S/(L+M)) axis of the diagram was scaled so that thresholds in the two cardinal directions were identical at the chromaticity of D65. At a given reference chromaticity, we measured thresholds for *saturation* (i.e. radial along a line passing through the chromaticity of D65) and for *hue* (i.e. tangential to a circle passing through the reference point and centered on D65).

Measurements were made in the fovea, using an adaptive, four-alternative, spatial forced choice procedure, which tracked the difference in chromaticity needed to identify the target correctly on 79.4% of trials. Five independent estimates were made of each threshold.

Except for stimuli very close to the white point, saturation thresholds were systematically higher than those for hue. This general law is curious, since in many models the extraction of saturation is distal to the extraction of hue. We offer an explanation in terms of correlated noise in the cardinal chromatic channels. There is empirical evidence for such correlated noise in spatially proximate ganglion cells carrying different chromatic signals[5].

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Psychophysical discrimination of movement extent for structures without muscle spindles compared with conventional joints

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Psychophysical testing involving joint-specific active movement extent discrimination apparatus (AMEDA) has been used to measure proprioception of body segments in research settings. Proprioceptive sensitivity has been measured by calculating the average pairwise area under the curve (AUC), or by calculating the just noticeable difference (JND). When the extent of an active forearm extension movement made to a physical stop without vision is considered as the stimulus intensity, the JND increases with rise in base intensity, although not as fast as predicted by Weber's law[1]. Accordingly, if intensity increments are fixed, pairs of adjacent stimuli should become increasingly difficult to discriminate as base intensity increases. At the ankle, the pair-wise AUC discrimination index for active inversion movements decreased linearly with successive one degree increments in the amount of inversion[2]. Because all conventional joints involve rotation of bony segments, the discrimination capacity for movements of different extents was examined at the lips, where the muscles producing the movement have no bony attachment or muscle spindles, and at the jaw, a conventional hinge joint. The same test was employed for testing proprioceptive sensitivity of both lips and jaw (Fig. 1), which involved closing from a 30 mm opening onto the stimulus, a plastic plug of 5, 6, 7 or 8 mm diameter, and responding 1, 2, 3 or 4. ROC curves were then constructed for stimulus pairs 1–2, 2–3, and 3–4. For the range of closure movements tested, at the lips there was a consistent AUC score of 0.839 across all 3 stimulus pairs; whereas at the jaw results were; pairwise AUC 1–2=0.789; 2–3=0.805; 3–4=0.766, suggesting that movement extent can be seen as stimulus intensity only for rotating body segments. At the lips, thickness rather than distance moved may have been used to perform the discrimination task.

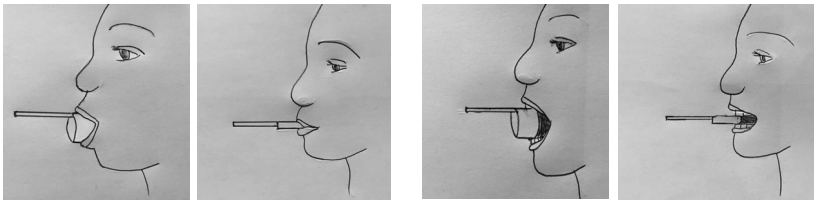

Fig. 1. Panels show the start 30 mm opening and closure onto a stimulus piece, for the lips and jaw

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The role of tonal structure in major and minor chords perception

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The study of tension and relief in contemporary psychology of music are almost exclusively concentrated on tonal characteristics[1]. Major and minor is the core of European system of tonality. It is widely believed and taken for granted that tonal structure (the relative position of the third degree) is itself sufficient for construction of known emotional patterns that are associated with major and minor. This assumption was tested. Special stimuli were constructed with the frequencies set corresponding to major and minor triad chords but without any alteration of sounds intensity in time as well as relative intensity of the stages. Stimuli varied from A5 to Dm5 (the total of 8 triad chords, natural scale, not tempered), intensity 70 db, each was presented for 2.5 seconds, quasi randomly, first separately, then in pairs. Two studies were performed. During the first study the subjects (N=20) were asked to identify the nature of stimuli and freely describe emotions and associations connected to them. During the second study the subjects (N=27) were asked to evaluate the stimuli according to scales that were adopted from the first study on the basis of content analysis. Subjects varied in their musical skills from semiprofessional to none. Only one subject (semiprofessional, clarinet) identified the nature of the stimuli and correctly attributed most of them to major or minor. Two subjects (semiprofessional, piano and professor of aesthetics) implicitly identified some of the stimuli as the parts of possible harmonies but were unable to identify their nature. Two significant correlations were found between purely tonal "Major/minor" and subjective scales: "Active–passive" (Spearman r=0.19, p=0,0025) and "Boredom–interest" (Spearman r=0.13, p=0,036). The most interesting finding is that purely tonal minor is evaluated as more "active" than purely tonal major (Mann–Whitney test p=0,0027). Results of both studies show that in spite of tonal correspondence the stimuli are not identifiable as major and minor triad chords, nor do they produce culturally expected associations. Purely tonal component is not sufficient for major–minor effects and cannot be understood without the study of sound's attenuation process. The fact that spectral set of minor is estimated as more "active" permits proposal of the following preliminary explanation within the framework of the resources model of music perception[2]. Initially more intensive demand for neural resources while fading of sound produces deeper sense of their lack. Exact investigation of these process timing parameters can help in understanding psychophysiological mechanisms of neural resources management in human brain and psyche.

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Changes in the Psychophysical Profile of Auditory Temporal Processing as a Function of Aging

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Historically, it seems that the overriding interest in the effects of aging on auditory temporal processing began mainly as an adjunct of the (more important, more relevant) research and clinical question as to why older adults often complain of difficulties in understanding people speaking when speech is presented against background noise or when speech is very rapid. In general, one must be able to *process auditory information at a rapid pace* in order to develop appropriate listening and speaking skills. Audiologists have recognized this problem in people with sensori-neural hearing loss, and have referred to this concept as the "temporal window". If the time period required to process sound (temporal window) is too long; it becomes more difficult for an individual to understand speech. Any brief change in the speech signal then becomes difficult to perceive and the communication may be distorted.

A large number of cross-sectional studies published over the past 25 years reported significant age-related declines in auditory temporal resolution. These studies used a variety of testing paradigms including: temporal order judgment, gap detection, duration discrimination, localization and lateralization, masking level differences, detection of amplitude modulation, and detection of temporal asynchrony. In the current study, we addressed the following question: Is there a general age-related change in the dynamics of the auditory temporal window that leads to a shared deficit in all tasks that are dependent on temporal resolution and discrimination? We attempted to build a psychophysical profile of aging by adapting the Brinley plot analysis to compare young and elderly participants on auditory temporal processing as measured by: lateralization, gap detection, duration discrimination and dichotic TOJ thresholds.

In the mid 1960s, Brinley presented a novel plotting method to consider the relationship between response times in young and older adults across a variety of tasks with varying levels of cognitive difficulty. The average response times for both the young and older groups of adults on each task were placed on a scatter-plot, and a regression line was then fitted to the data. In doing so, a linear relationship was found between the response times in young adults and the ability to predict behavior on the same task in older adults. The power of this method of data analysis lies in the fact that it can be used across a variety of tasks to pool data from multiple studies and serve as a meta-analytic tool to answer more general questions.

In the current cross-sectional study we applied the Brinley plot analysis to age-related auditory temporal processing data. We compared young and older participants on auditory temporal processing as measured by: 1) lateralization, 2) gap detection, 3) tone duration discrimination; and 4) dichotic TOJ. The results of the current study of age-related changes in temporal processing were complex. We found significant age-related changes only for the dichotic TOJ thresholds but not for lateralization, gap detection, or duration discrimination. However, when we applied Brinley plot analysis and plotted all of the auditory temporal processing thresholds of the older participants (age: 68±6.55) against those of the young (age: 24±2.65) for all of the four paradigms together with the thresholds from 34 earlier studies that used the same paradigms (k=38 studies) the resultant Brinley plot could be fitted by a linear equation with a slope of 1.43, that explained ~ 95% of the age-related changes in auditory temporal processing. Thus a psychophysical profile model that predicts approximately 40–45% general increase in all temporal thresholds may explain the majority of the variance in age-related auditory temporal processing deficit.

In summary, we have *no* direct empirical evidence for a *general deficit* in processing of the temporal parameter in a within-subjects design: Different temporal paradigms may be differentially affected by aging. This means that a given individual may show the effects of age-related changes in one auditory temporal processing task, but not in another. However, Brinley plot analysis of the auditory temporal processing thresholds of older adults against their young controls yields a linear slope of 1.43 or 1.44 that accounts for approximately 95% of the variance. This suggests that there may also be an overall age-related general shortening of the "temporal window", so that temporal thresholds of older adults are generally ~40–45% longer than that of the younger controls.

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Masking as an additional cue for performing auditory spectral TOJ

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Auditory temporal processing, i.e., the rate at which we process auditory information, is essential for general listening skills and for the development and maintenance of normal language comprehension and reading skills. Auditory temporal processing has been assessed over the past several decades by using a variety of psychophysical tasks, among them are the widely used spatial (dichotic) and spectral temporal order judgments (TOJ). Spatial TOJ involves the presentation of a tone to one ear followed after an inter-stimulus interval (ISI) by the same frequency tone to the other ear. Participants respond as to which ear received the tone first and which received the second. Spectral TOJ involves the presentation of two tones of different frequencies (one tone is higher in frequency than the other) separated by an ISI, presented either to both ears simultaneously or to one ear alone. Participants respond as to the order of the presentation of the tones, low before high or high before low. Researchers have related to performance on both of the TOJ paradigms as evidence of the ability of the individuals to use the temporal cues provided by the ISI separating the tones, so that any performance deficit in either spatial or spectral TOJ has been treated as evidence of deficit in auditory temporal processing. However, two lines of evidence suggest that spectral TOJ may not be a measure of temporal processing in the same way as spatial TOJ: (1) Previous findings show that accuracy of spectral TOJ plotted against stimulus-onset asynchrony (SOA, the temporal separation between the onset of the tones), predicts only 54% of the performance (while for spatial TOJ, it predicts 97%)[1]; (2) A meta-analysis of 388 participants obtained from 13 of our studies show that ~50% of participants succeed in reproducing the order of the tones (spectral TOJ) when almost no interval separates them (ISI<5 msec)[2].

These findings raise the question: if the temporal cue is not a major factor in performing spectral TOJ, what other cues are available and how do they affect performance? In the present paper, we posit that the structure of the spectral TOJ paradigm provides participants with perceptual cues based on the order of presentation of short tones of different frequency in addition to the temporal disparity (ISI) which provides the temporal cues. More specifically, presenting a low frequency tone followed by a high frequency tone after a very short or even no ISI and vice versa provides opportunities for forward and backward masking of the high frequency by the low frequency tone. Each "masking pattern" sounds sufficiently different to provide an additional cue for discriminating the low-high from the high-low pairs.

The results show that (1) when tones are in the lowest rang of the spectrum (300–600 Hz, 600–1,200 Hz), large number of participants (80–90%) perform spectral TOJ with ISI<5 msec, than when tons are in the middle range (1,000–2,000 Hz, 48%) or in the high range 3,000–6,000 Hz, 10%); (2) when tone are within the critical bandwidth (1,000–1,100 Hz, 1,000–1,800 Hz) they produce more ISI<5msec responses (50–60%), than when they are outside the critical bandwidth (1,000–3,500 Hz, 30%).

The results support our hypothesis that masking cues are available when performing spectral TOJ, at least for some of the participants, in addition to spectral cues. They suggest that spectral TOJ does not necessarily measures temporal resolution, but maybe sensitivity to masking cues. This carries important implications for interpreting previous studies using spectral TOJ, and for the future use of this task in testing auditory temporal processing in general, and in groups suspected of temporal processing deficit.

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Auditory temporal perception of the stimuli as factors of signal processor

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The perception of auditory durations was measured in many studies of which different parameters are used. In this connection one study was conducted[1] which used a model entitled "Auditory-brain system"[2] where stimuli are explained by autocorrelation function (ACF; e–1) as a signal processor[2].

$$\emptyset(\tau) = \frac{1}{2T}\int_{-T}^{+T} p(t)p(t+\tau)dt \qquad \text{(e-1)}$$

Where, $p(t)$ is the stimulus at the entrance of the ears is the delay time, and $2T$ is the integration interval. In such ACF analysis, there are four parameters, namely:

(a) the energy represented at the origin of the delay, $\Phi(0)$; (b) the amplitude, $\phi 1$, between the first peak and the zero crossing number; (c) the structure including the time delay of the first peak, $\tau 1$ and (d) the effective duration of the envelope of the normalized ACF, τe, which is defined by ten percentile delay or at which the envelop of the ACF becomes –10 dB.

In this study, two different stimuli of pure-tone and complex-tone were determined by the digital analysis of the ACF. Those stimuli were presented in the anechoic chamber for getting subjective responses under pair-comparison test spectrum. Data were collected on the 50% and 75% lines in the psychometric function according to psychophysical law. Pure-tone and complex-tone durations with different frequencies (f) and fundamental frequencies ($f0$), respectively were tested subjectively under three experiments. Stimuli durations were selected from 140 ms to 240 ms with 10 ms gap. Standard and comparing durations were maintained for the both of inter-pair and intra-pair gaps. Standard duration was 120 ms. Those stimuli produced two different waveforms which make same pitch and similar duration perception.

Results revealed that the frequency and fundamental frequency both are the factors of subjective duration of auditory stimuli. It also showed that the duration perceptions were found almost similar ($p<0.05$) between pure-tone and complex-tone stimuli where f and $f0$ with the same value, in spite of different signals waves. Such results indicate to formulate another new law of psychophysics which may consist of a mathematical equation. This equation could make resultant between two different waveforms (f & $f0$) of the stimuli but same pitch. This law can have unified capacity of psychophysics. So it can be recommended here to conduct more experiments to formulate the expected equation in this connection.

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Historiography of Fechner Days by counting words

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Objective of this study was to identify the shifts in the research focuses of the International Society for Psychophysics in the years from 1987 to 2011 by counting the words in the published corporates. For this purpose all abstracts of the professional articles were considered and all words were counted. The words were clustered sensibly to organize the amount of data. Afterwards all data were charted and graphed to enable an uncomplex representation of the findings.

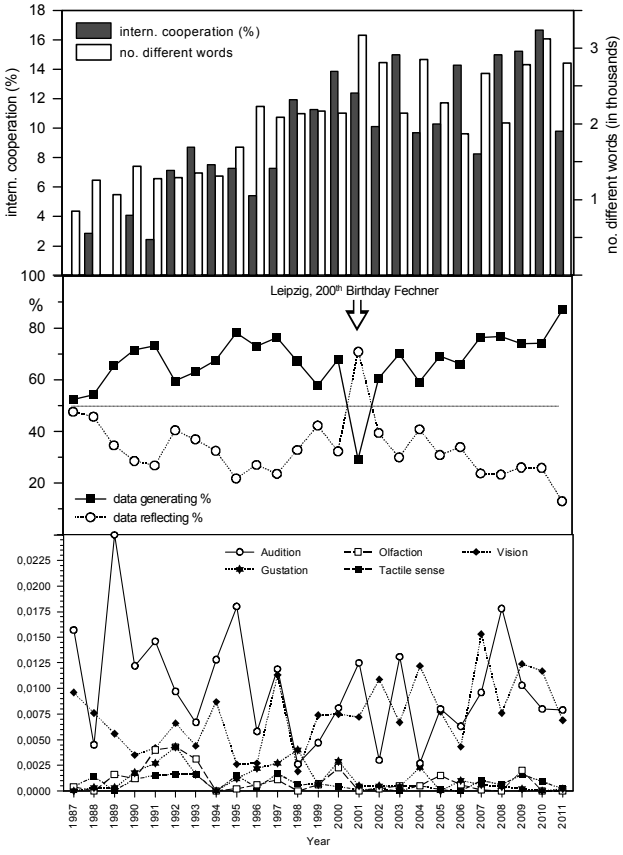

Fig. 1. Upper graph: international cooperations between authors from different countries (%) and no. of different word (in thousands); Middle chart: No. of data generating and data reflecting articles (%); Lower picture: Percentage of counted words related to 5 senses

The quantitative evaluation of the research focuses showed that the yearly Fechner Day meeting is a growing event. More articles are published from year to year, the number of words and a) the variety of vocabulary rises. Furthermore findings show an increase in b) cooperation between authors from different countries. Moreover the number of female first authors rises and c) there is also a growth in empirical studies. The analyses of specific words and terms such as “subjects”, “magnitude estimation” and “reaction time” show that some words are preferred and more likely to be used whereas others are obsolete. The research in the field of sensory sensations is highly developed. A great number of experiments are conducted to examine audition and vision. The research of d) the senses of tactition, gustation and olfaction are underrepresented.

The method of quantitative evaluation is a simple way to detect shifts in the interests of certain academic disciplines. It can be used to reflect on the published studies so far and to draw the scientists’ attention to unattended fields of research detected by the statistical data.

In summary it can be said, that it is possible to conduct historiographical analyses just by counting words.

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Why Finsler geometry is good for color perception

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The concept of sensory space is often used for the pictorial presentation of psychophysical data. The elements of this space correspond to the stimuli in use and the distances between them should coincide with the subjective estimates of the differences. The attractiveness of geometric interpretation is explained not only by a clear demonstration, but as a possibility to obtain a description of sensory analyzer that is not dependent on specific sets of test stimuli. These stimuli often play the role of basic vectors. Hence a model definition should exhibit the invariant geometric properties that are not concerned with the particular basis imposed by the experimental procedure.

Hermann von Helmholtz pioneered in applying this approach to the geometry of color space[1]. He followed the key idea of Gustav Theodor Fechner: the scale of sensation should be derived only from experimentally found relations between the neighbor stimuli (thresholds). Developing Fechner's idea for multidimensional color space, Helmholtz suggested to apply differential geometry methods. First, a threshold distance between the neighbor color stimuli is defined (theoretically or as experimental dependence) on the tangent space at each point. Then the distance between any remote stimuli is calculated as geodesic length. Helmholtz suggested a theoretical model of local distance (linear element), using particular case of differential geometry – Riemannian geometry. Here a tangent space is considered as Euclidean with quadratic norm. So, the line element of Helmholtz is simply a weighted sum of the squared differential thresholds for the three basic colors. In compliance with this theory, if we fix some color as a center of an area of indistinguishability (i. e., all other colors that a subject could not distinguish from it), this area will be of an elliptical form.

The concept of Helmholtz has gained general acceptance. By now a set of different line elements has been suggested to most closely correspond to experimental data[2]. However the Riemannian formalism for color space remains intact. Nevertheless, the experimental estimates of color distances are in rather poor agreement with geodesic distances predicted with various line elements. This sends us in search of further generalization of the theory. To do this we would require first to realize that in physics (essentially in relativity theory) the Euclidean tangent space is a consequence of matching principle: our local three-dimensional space is Euclidean. But there is no particular reason why this should be so in color space.

Rejecting this assumption, we arrived at the use of the so-called Finsler space[3], and can state the necessary and sufficient geometrical criterion of validity of Finsler model in psychophysics. In distinction to Riemannian space, the form of a region of indistinguishability in Finsler space may be arbitrary, but convex. For each convex region of indistinguishability a local metric function could be estimated. Then geodesic distances could be calculated in the regular way.

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DECISION MAKING AND CONFIDENCE IN SENSORY TASKS

Contingencies, Pseudocontigencies and Selective Attention: An Integrative Study of Speeded Human Decision Making

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Timely inference and predictions in the probabilistic world are indispensable for survival. Two factors have been shown to drive the pertinent cognitive processes: the correlation between the variables of interest and their marginal frequencies or base rates. The two sources of information can complement each other so that one can become gratuitous when the other is also available. Unequal base rates often render correlation unnecessary. High base rate events can be predicted and relied upon without ever understanding or explaining the conditions under which they occurred. Given their critical importance for survival and adaptation, people often utilize a cognitive illusion – pseudocontingency (PC). Correlation requires information on the joint occurrence of two variables in the same individual stimulus. When these data are not available, correlations are inferred nonetheless from the base rates of the two variables. However, this adaptive cognitive function has not been tested under requirements of speedy responding characteristic of everyday life. Moreover, the role of pre-existing semantic relationship between the variables has not yet been appreciated. Of equal importance is the measurement of actual performance (apart from verbal assessment of any contingency) and the quality of attention to each of the pertinent variables. Semantic relationship, failure of selective attention, and time constrain can become possible obstacles to good decision making. Therefore, the goal of this study was to provide a comprehensive portrayal of the statistical sources of human decision making under speeded and non-speeded responding using explicit and implicit measures.

The prime vehicle for testing speeded performance with semantically-bonded variables is the Stroop effect (SE). When presented with color words printed in various ink colors and asked to name the color, people cannot overcome the tendency to read the irrelevant words even when doing so can hurt color performance. The SE is defined as the difference in color performance between incongruent (the word RED printed in ink color green) and congruent (RED in red) stimuli. A greater than zero SE betrays the influence of the task-irrelevant words, compromising exclusive attention to the target color.

In the current study, Values of Stroop variables were conjoined in a factorial fashion, creating congruent and incongruent stimulus combinations. An array of such matrixes was constructed, governed by different values of the base rate of the constituent variables (hence producing also different signs of pseudocontingency) and inter-variable correlation over the experimental trials. This comprehensive set of base rate and correlation mapped all possible combinations of these sources of information. For responding, we employed non-speeded as well as speeded tasks. For the former, the participants assessed the value of contingency and of base rate via different verbal estimates. For the latter, we derived the absolute reaction times as well as the classic measures of the SE

Our results suggest the possibility of differences in the action of base rate when it is applied to non-speeded measures of prediction and its application to speeded measures, particular that of Stroop, which entails semantic relations between the tested dimensions. The results highlight the structural differences between Stroop measures, on one hand, and those of prediction and judgment on the other hand. In the Stroop task, manipulations of base rate and correlation affect the SE by changing the proportion of congruent (and incongruent) stimuli. Given the absence of an a priori semantic relation in studies of judgment and prediction, base rate and correlation affect absolute performance without recourse to congruent and incongruent cases that simply do not exist.

Systematic comparisons between the distinctive effects of base rate and correlation on different stimuli environments and different tasks offer a more comprehensive understanding of the cognitive processes underlying human behavior and performance. Additional studies are needed to further investigate the effect of these contextual factors on different tasks and in different environments.

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Development of confidence model on the basis of Signal Detection Theory

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To start confidence modeling we have to answer a general question first: what is confidence in decision-making? Now the concept of confidence has no accurate and unambiguous definition either in technical sciences, or in the humanities. In the case of psychophysics, confidence isn't defined properly not only for a real observer, but even for an ideal one. As the behavior of an ideal observer is much easier to explain, than that of a real one, the consideration of an ideal observer's confidence is the first thing we have to do.

The model of signal/noise discrimination developed within the Signal Detection Theory (SDT)[1] gives us a general idea of how an ideal observer makes a decision while performing a sensory task. After obtaining a sensory effect x, the ideal observer has to choose a response (either **Y** for a signal or **N** for noise) with the greatest a posteriori probability of responses correctness ($P(\mathbf{Y}|x)$ or $P(\mathbf{N}|x)$) or the greatest a posteriori average utility (either $\underline{V}(\mathbf{Y}|x)$ or $\underline{V}(\mathbf{N}|x)$). According to Egan[1], $P(\mathbf{Y}|x)=\psi/(1+\psi)$, $P(\mathbf{N}|x)=1/(1+\psi)$ and $\underline{V}(\mathbf{Y}|x)=\psi/(1+\psi)v_{\mathbf{sn},\mathbf{Y}}+1/(1+\psi)v_{\mathbf{n},\mathbf{Y}}$, $\underline{V}(\mathbf{N}|\Psi)=\psi/(1+\psi)v_{\mathbf{sn},\mathbf{N}}+1/(1+\psi)v_{\mathbf{n},\mathbf{N}}$, where $\psi=P(\mathbf{sn}|x)/P(\mathbf{n}|x)=\lambda l(x)$ – is a ratio of signal and noise a posteriori probabilities, $\lambda=P(\mathbf{sn})/P(\mathbf{n})$ – is a ratio of signal and noise a priori probabilities; $l(x)=f(x|\mathbf{sn})/f(x|\mathbf{n})$ – is a likelihood ratio in favor of the signal; $v_{\mathbf{sn},\mathbf{Y}}>0$, $v_{\mathbf{n},\mathbf{N}}>0$ – are correct responses values, $v_{\mathbf{sn},\mathbf{N}}<0$, $v_{\mathbf{n},\mathbf{Y}}<0$ – are incorrect responses costs.

At present there are several SDT-based models, which describe both decision-making and confidence assessment. The authors of these models believe that the observer uses a decision-making criterion which is localized on the axis of the sensory effect x. After making a decision-choice he/she estimates his/her confidence as a distance between the criterion and the sensory effect x obtained during observation. This way of decision-making and confidence assessment can be applied to the "greater–lesser" task. However it isn't applicable for the "same–different" task, because in this case there are two criteria on the sensory axis but the observer does not have any instruction showing which of them should be used.

When instead of variables λ, $l(x)$ and ψ we used their natural logarithms: $\Lambda=ln(\lambda)$, $L(x)=ln[l(x)]$ and $\Psi=ln(\psi)$, we got new important formulas[2,3]: $\Psi=\Lambda+L(x)$, $P(\mathbf{Y}|\Psi)=0{,}5+0{,}5\,th(\Psi/2)$, $P(\mathbf{N}|\Psi)=1-P(\mathbf{sn}|\Psi)=0{,}5-0{,}5\,th(\Psi/2)$, $\underline{V}(\mathbf{Y}|\Psi)=[(v_{\mathbf{sn},\mathbf{Y}}+v_{\mathbf{n},\mathbf{Y}})+(v_{\mathbf{sn},\mathbf{Y}}-v_{\mathbf{n},\mathbf{Y}})\,th(\Psi/2)]/2$, $\underline{V}(\mathbf{N}|\Psi)=[(v_{\mathbf{sn},\mathbf{N}}+v_{\mathbf{n},\mathbf{N}})+(v_{\mathbf{sn},\mathbf{N}}-v_{\mathbf{n},\mathbf{N}})\,th(\Psi/2)]/2$. It's obvious that when the variable Ψ increases, probability $P(\mathbf{Y}|\Psi)$ and average utility $\underline{V}(\mathbf{Y}|\Psi)$ increase monotonically as well. At the same time $P(\mathbf{N}|\Psi)$ and $\underline{V}(\mathbf{N}|\Psi)$ decrease monotonically. Therefore $\Psi=\Lambda+L(x)$ may be called "the a posteriori evidence in favor of the signal". Because of the functions $P(\mathbf{Y}|\Psi)$ and $P(\mathbf{N}|\Psi)$, $\underline{V}(\mathbf{Y}|\Psi)$ and $\underline{V}(\mathbf{N}|\Psi)$ monotony, they have only one intercept. Therefore the ideal observer has only one decision-making and confidence assessment criterion on the axis Ψ. Thus due to improving signal processing in SDT, we have obtained a new approach, which is rather general since it is suitable both for the "greater–lesser" sensory task and for the "same–different" one. In our works[2,3] we proved that confidence feeling is an efficiency indicator (namely, the correctness probability or the average utility) of the response chosen, which may be used for the best response prediction. If the ideal observer's goal is to choose a response with the greatest correctness probability, then the confidence is: $C_{\text{cor}}=\Psi=\Lambda+L(x)$. The observer's response is **Y**, if $C_{\text{cor}}>0$, otherwise it is **N**. If the goal is to choose a response with the greatest average utility, then the confidence is $C_{\text{util}}=\Psi+\Sigma$, where $\Sigma=ln[(v_{\mathbf{sn},\mathbf{Y}}-v_{\mathbf{sn},\mathbf{N}})/(v_{\mathbf{n},\mathbf{N}}-v_{\mathbf{n},\mathbf{Y}})]=ln(s_{\mathbf{sn}}/s_{\mathbf{n}})$, which may be called "an evidence in favor of the signal significance". The observer's response is **Y**, if $C_{\text{util}}>0$, otherwise it is **N**.

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Bayesian approach for estimating discriminability *d′* with an extreme response criterion

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In Psychophysics, Signal Detection Theory is often used to estimate discriminability, d', independently from a response criterion. The theory for estimating d' is formulated by assuming that the number of trials is infinite, an assumption that can never be satisfied in practice. It follows that the estimation of d' becomes unstable if the criterion is strongly biased. Note that the estimated d' will be inflated to *infinity* whenever the hit and correct-rejection rates are 0% or 100%. Here, I propose a method that computes a 1D likelihood distribution of d' by combining: (i) a 2D likelihood distribution of d' and the criterion and (ii) a 1D prior distribution of the criterion for given d'.

The 2D likelihood distribution of d' and the criterion β is derived as[1]:

$$L(d',\beta|N_{SN},N_N,n_h,n_f) = \binom{N_{SN}}{n_h} H(d',\beta)^{n_h}\left(1-H(d',\beta)\right)^{N_{SN}-n_h}\binom{N_N}{n_f} F(d',\beta)^{n_f}\left(1-F(d',\beta)\right)^{N_N-n_f}$$

$$\begin{cases} H(d',\beta) = \Phi(-\beta + d'/2) \\ F(d',\beta) = \Phi(-\beta - d'/2) \end{cases}$$

where Φ is the cumulative standard normal distribution function and N_{SN}, N_N, n_h, and n_f are numbers of signal+noise trials, of noise trials, of hit trials and of false-alarm trials. The prior distribution is derived by assuming that hit and false-alarm rates are never 0% or 100%:

$$\begin{aligned} \text{Prior}(\beta|\, N_{SN},N_N,\, d') \;= 1 - {} & p(n_h/N_{SN} = 0 \text{ or } 1 \text{ or } n_f/N_N = 0 \text{ or } 1|\, N_{SN},N_N,d',\beta) \\ & + p(n_h/N_{SN} = 1 \text{ and } n_f/N_N = 0|\, N_{SN},N_N,d',\beta) \\ & + p(n_h/N_{SN} = \;0 \text{ and } n_f/N_N = 1|\, N_{SN},N_N,d',\beta) \end{aligned}$$

This prior is justified in most behavioral experiments because the subjects are usually encouraged to maintain neutral criteria. This prior is very conservative and its effect on the estimation of d' is minimal except when the criterion, β, is highly biased.

From these two distributions, the 1D likelihood distribution of can be computed by marginalizing the criterion, β[2]:

$$L(d'|N_{SN},N_N,n_h,n_f) = \int_{-\infty}^{+\infty} L(d',\beta|N_{SN},N_N,n_h,n_f)\,\text{Prior}(\beta|\, N_{SN},N_N,\, d')\mathrm{d}\beta$$

Note that this 1D likelihood distribution can be computed even when the hit and correct-rejection rates are 0% or 100%. This new method will be compared with existing methods that adjust the measured hit and false-alarm rates between 0% and 100% to estimate a finite d' (see 3 for a review of the existing methods).

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Involvement in a task and ambiguity tolerance as factors of criterion control

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The paper sums up a long-term experimental investigation of the role of personality characteristics in the observer's choice of a certain criterion of decision optimality in psychophysical tasks. The author's theoretic model[1] describes transition from an external objective-set task into a subjective criterion of decision optimality. Different kinds of optimality criteria are compared to two classes of tasks distinguished by the general systems theory[2]. The subject's choice of the criterion of minimum uncertainty or the criterion of maximum efficiency is considered as a result of subjective transformation of an objective-set task either into the task of satisfactory decision search or the task of optimization. Iindividual differences in subjective representation of the task, its transformation based on the satisfaction principle or on the optimization principle and a following choice of the decision criterion depend on such personal traits of a decision-maker as action vs state orientation[3] and ambiguity tolerance[4]. A series of experiments[5] has proved the role of task involvement (action control) and ambiguity tolerance as the two main factors of criterion control. 50 subjects (cadets of pilots college) took part in signal detection and monitoring procedures, passed personal tests and were rated in flight training.

Different decision optimality criteria were observed *in the "seen"–"not seen" discrimination experiment*: real optimization criteria correlated with action orientation and uncertainty tolerance (stabilization of correct responses ratio, Zigert's criterion of correct response percentage maximization, Bayes's criterion of minimum uncertainty), and criteria of satisfactory decision; the latter were specific to state-oriented persons with high intolerance to ambiguity (fixation on positive responses percentage, the Neyman-Pearson criterion of stabilization of false-alarm rates, stagnant fixation of likelihood ratio in conditions of changeable signal probability, Vickers's paradoxical criterion). *Visual discrimination tasks at accidentally different or sequentially increasing signal strengths* revealed different types of criterion control: from the absolutely inefficient, random or stagnant decision strategy (a combination of high rates of state orientation and uncertainty avoidance) to the most efficient and linear way of maximizing the correct responses ratio (a harmonious combination of high uncertainty tolerance and action orientation – initiative and responsibility). *In the signal equalization tasks* a component of most inefficient, satisfactory and non-optimum decision (more long-term, more "diffuse", less "accurate", more cautious, less confident) was characteristic for observers who were intolerant to ambiguity, avoiding innovations, unconcerned with the task and oriented to a subjective state. Finally, those observers who demonstrated the most efficient and optimum models of criterion control, turned out to be the most successful in the pilots' professional training ("flying ability", the speed of learning piloting skills and spatial orientation).

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The phenomenon of confidence in sensory discrimination, general knowledge and self-confidence in Russian and German cultures

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This work is an experimental cross-cultural study of the psychological concept of "confidence". 2 components of confidence were revealed before: personal and decision-making ones. We investigated the decision-making component in sensory and general knowledge tasks[1, 2].

The paper compares the components of confidence in Russian and German samples. Participants: males and females, 19–33 years old, Germans – 20 people, Russians – 32 people.

Methods

1. The sensory task: visual durations discrimination between light flashes presented in pairs: a standard duration (600 ms) and a comparable one (600 ms – Δt) differed at a difference threshold level: individual Δt values were found in a preliminary session which gave 70–80% correct responses. 2 responses were given in each of 120 trials by each participant: 1) whether the stimuli in a pair were equal or different; 2) whether an observer was confident or unconfident in his/her 1st response correctness. Indices calculated: a proportion of correct responses, an average confidence category used (in percent), index of realism of confidence: Bias – a difference between the average confidence category and the proportion of correct responses.
2. The general knowledge task: the subtest "Awareness" in Universal Intelligent Test[1].
3. Questionnaire of self-confidence[3].

Results obtained. A) In the sensory task: 1) no significant difference in visual durations difference thresholds were found between Russians and Germans; 2) overconfidence (exceeding of average confidence category as compared to percent correct) was found in Russian subjects and in German as well; B) In the general knowledge task: 1) a difference between Russian and German participants was revealed in the middle category of confidence, realism of confidence, proportions of incorrect confident and incorrect unconfident responses: Russians were overconfident in their knowledge correctness, while Germans had a lack of confidence when they answered general knowledge questions; 2) a significant relationship between self-confidence and confidence in responses correctness was obtained in the total sample; C) Self-confidence: there were no significant differences in self-confidence between Russians and Germans. But Russian men were more self-confident than German women.

The study findings. Thus, Russian and German participants were similar in visual durations discrimination and in their confidence in the discrimination correctness. But they differed in confidence in their knowledge. A cross-cultural comparative analysis of all combinations of subjects' responses (correct confident, incorrect confident, correct unconfident and incorrect unconfident) show that Russians give more confident incorrect responses, while Germans – more incorrect unconfident. Thus, Russians are confident even when they are wrong while Germans are doubt in this situation. Overconfidence revealed in Russians in general knowledge task while underconfidence found in Germans, show that Russians are more confident in their knowledge in various fields of history, art, science and life in general.

Russians and Germans are similar in self-confidence. It means that they feel and react in the same way in different social and everyday situations. Both groups receive their actions, decisions, skills and abilities as appropriable.

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COGNITIVE FACTORS IN PERCEPTION AND PSYCHOPHYSICS

Quantum-like Model of Sensation-Perception Dynamics

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We present a quantum-like model of sensation-perception dynamics (originated in Helmholtz theory[1] of unconscious inference). This model is based on the theory of quantum apparatuses and instruments. We illustrate our approach with the model of bistable perception of a particular ambiguous figure, the Schröder stair. This is a concrete model[2] for unconscious and conscious processing of information and their interaction.

The starting point of our quantum-like journey was the observation that perception dynamics is essentially contextual which implies impossibility of straightforward embedding of experimental statistical data in the classical (Kolmogorov, 1933) framework of probability theory. This motivates application of nonclassical probabilistic schemes. The quantum formalism provides a variety of the well approved and mathematically elegant probabilistic schemes to handle results of measurements.

The theory of quantum apparatuses and instruments is the most general quantum scheme describing measurements and it is natural to explore it to model the sensation-perception dynamics. In particular, this theory provides the scheme of indirect quantum measurements which we apply to model unconscious inference leading to transition from sensations to perceptions.

The approach used in this paper should be sharply distinguished from "genuine quantum physical models" of brain's functioning (in the spirit of Penrose) which reduce mental processes in the brain to the quantum physical processes in it. In our approach (called quantum-like) the brain is considered as a black box. Its information processing can be mathematically modelled with the aid of the formalism of quantum information theory and quantum probability theory. And such processing violates the laws of the corresponding classical theories. In particular, one of the basic laws of classical probability, namely, the law of total probability is violated by some statistical data which was collected in cognitive psychology and psychophysics. The common source of violation of classical laws both in quantum physics and those areas of psychology is contextuality: both quantum physical and mental systems are extremely sensitive to variation of experimental contexts. In philosophic terms one can speak about the impossibility to use the realistic viewpoint to quantum physical and mental observables.

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Visual working memory and unitization in rapid serial visual presentation

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Visual working memory (VWM) is a topic of vibrant discussions since the seminal study by Luck and Vogel measuring its capacity for visual features and objects[1]. Among the currently discussed problems is the influence of bottom-up and top-down factors on the information storage in VWM[2]. It has been shown to be influenced by perceptual organization[3]. However, less is known about the VWM temporal structure. Of interest is the issue of chunking, or unitization[4], when an observer is processing temporally distributed stimuli belonging to a larger whole, e. g. letters forming a word.

To probe into the nature of information buffering and chunking in VWM, we used a dual-task rapid serial visual presentation (RSVP), a procedure traditionally used to study the attentional blink phenomenon[5]. In our experiment, 24 participants were presented with 210 Russian words in a letter-by-letter manner (120 *ms* per letter with no interstimulus interval). All letters, presented in the center of a computer display, were printed in black, however, among them was a letter printed in white, followed by 4 or 5 letters and a mask (#). The participants were asked to report on the shape of the white letter (which could be either printed or handwritten) and to read a word beginning with it. The words used were mid-frequency 5- or 6-letter nouns. If a participant failed to report a word, (s) he was encouraged to name aloud all letters (s) he could identify. The procedure produced quite a number of errors classifiable into various types. The dichotomies we used for error classification were reporting either words or nonwords, skipping or not skipping letters in the reported strings (complete vs. incomplete report), adding or not adding letters not presented in the RSVP string, changing or not changing letter order, and reporting or not reporting on letters presented before the 1st target letter coloured in white. Distribution of errors was analyzed.

With most errors to be letter omissions or misidentifications, two groups of errors were of special interest as regards VWM. First were anagram errors such as reporting on all letters but in a wrong order forming either a nonword or a different meaningful word (e.g. “Thread” presented, “Hatred” reported), 25.1% of all errors. Second were reporting on letters presented before the white target letter as a part of the target string, also producing either a nonword or a meaningful word, 24.6% of all errors (e. g. “…dfrSpite” presented, “Sprite” reported). The analysis of these two groups of errors allows assuming that the order of temporally distributed stimuli is not encoded during their presentation (a result agreeing with some previous findings[6]), and the to-be-reported larger units are first to be constructed. The data also support the hypothesis that VWM is subject to top-down strategic regulation such as maintaining the maximum number of stimuli accompanying the 1st target (the white letter) as a reference mark, but not allowing to distinguish between stimuli preceding and following it.

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The recognition of fragmented images in schizophrenia

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There are two general approaches to the problems of perception and pattern recognition: identification of the global statistical properties of the image and the selection of local informative features of the highest order. These approaches describe two different mechanisms that may be involved in the recognition of objects. It is the mechanism of global and local descriptions of the image. Local description is based on the local features of the image, the global one is based on the statistical characteristics of the holistic image. The problem consists in studying functional characteristics of these mechanisms, especially their interactions, the role of the interaction in ensuring the integrity of perception. One of the most efficient approaches to the study of mechanisms of vision, as well as of any other mechanisms is the study in extreme operating conditions, particularly in psychopathology. It is known that the dysfunction of the integrity of perception is a typical characteristic of individuals suffering from schizophrenia. Disorders can occur at different levels: at the level of detection, distinction or identification of the object. The purpose of the study is to investigate the mechanisms of global and local analysis, features of their interaction and the role of interaction in ensuring the integrity of perception in the task of identification using fragmented images on the model of schizophrenia. The objects of the research are 24 mentally healthy persons (23–42 years) and 54 patients with schizophrenia (19–64 years). We use a copyrighted computer version of the Gollin test with contour images. We measured the minimal total area of fragments in percentage proportion to the total area of the contour at the moment of identification of the stimulus. It was found that patients with schizophrenia require more contour fragments to identify the object compared to healthy subjects. Individuals with first-episode schizophrenia require fewer fragments for identification of the object contour than those chronically ill, as well as patients with paroxysmal type of the disease compared to those with a continuous type. The study proves the dysfunction of the mechanisms of identification of fragmented figures in schizophrenia, that is, mechanisms for building a complete image. Based on the theory of spatial-frequency filtering in the visual system, those are the mechanisms of global and local analysis. Thus, we have demonstrated the dysfunction of the mechanisms of global and local analysis at the highest levels of information processing and showed that the severity of these disorders depends on the clinical picture and type of the disease.

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Sensory-Cognitive Interactions in Letter Identification: Familiarity and Aging Effects

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The identification of objects in the visual field becomes more difficult the more "cluttered" the visual field becomes. For example, the ability to identify a single target letter presented at the fixation point is compromised when that target letter is surrounded by other letters[1]. Poorer letter identification performance in a cluttered visual field could reflect difficulties in segregating the target letter from the surrounding letters (a perceptual level difficulty), or it could reflect more central cognitive level processes such as the intrusion of the surrounding visual objects into 'working memory'.

In the first of the experiments reported here the target object was one of the 26 capital letters of the English alphabet. These letters were presented against four different backgrounds: (1) a background field consisting of randomly chosen and randomly oriented English capital letters; (2) a background field consisting of the fragments of the same surrounding letters; (3) a background of visual noise having the same spatial frequency content as that of the letter masker; and (4) a field in which the pixels comprising the letter masker were randomly positioned in the visual field.

We might expect the intrusion of other letters from the surround into working memory to compete for working memory resources, thereby interfering with the detection and identification of the target letter. We might also expect letter fragments in the background to be easier to exclude from working memory and, if they did manage to intrude into working memory, that they would not compete for attentional and processing resources to the same extent as when surrounding letters found their way into working memory. Hence, we might expect a surround consisting of other letters to interfere more with target letter identification than a surround consisting of letter fragments. The visual noise masker having the same spatial frequency content, would be expected to provide the same degree of peripheral masking as the letter masker but should not elicit any competing activity in working memory. The noise masker consisting of a random rearrangement of the pixels, because it would have a flat frequency spectrum, should not be as potent a peripheral masker as the noise masker with the same spectral content as the letter masker, even though it would have the same RMS contrast. Hence we might predict letter identification to be poorer in the presence of a letter masker than in the presence of a masker consisting of letter fragments. Moreover, we expected to be able to use a comparison between performance in the presence of a letter masker versus performance in the presence of a visual noise have the same spatial frequency content to determine the contribution of peripheral masking to performance.

We also investigated the effects on performance of an artificial alphabet having the same spatial properties of English letters, and a Korean alphabet that was unfamiliar to participants whose native language was English. Surprisingly, we found performance to be best for letter maskers of all types, and that both the familiarity of the surrounding objects, and the age of the viewer, modulated the degree of interference with target letter identification, with the age effect primarily due to age-related losses in spatial-frequency resolution.

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Eye movements control in the visual search process: Influence of low and high level factors

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Visual search is an ecologically valid and important task. In recent years we have seen an increasing interest in the study of visual search of more complex and semantically loaded objects[1]. In the present study we have modeled a web search task and examined the dependence of eye movements in the visual search process on low-level factors, such as the chromaticity of the stimulus matrix, and on high-level factors, such as the format of presentation of the target stimulus. The stimulus matrix was either black and white or colored. We assumed that the introduction of color would complicate the search for incentives that would be reflected in the change of the search parameters. The target of the search was set either by a picture or by a word. If the target was set by a picture, the subject had to hold it in the working memory and to compare it with those he saw on the screen. If the goal was set by a word, subjects were required to mentally produce possible images of objects which they had to look for. The second situation was less certain and more complicated, and we assumed that it would increase time costs and affect the strategy of eye movements activity.

63 healthy volunteers took part in this experiment; 41 females and 22 males ranging in age from 18 to 48 years; mean age 22 y 3 m. The participants were seated 0.65 m away from a 19 inch computer screen. They were to find symbolic images of real-life objects (such as butterfly, cactus, book, etc.) among a variety of other objects. Image stimuli were arranged in rectangular full screen stimulus matrix 9×9. Each matrix contained 81 objects, one of which was the target. The target stimulus was situated in one of 8 quadrants (the central quadrant was not used). 32 matrices were shown, half of which were black and white, the other half was colored (Chromaticity Factor). The stimuli consisted of black circles or squares with either white or colored image of a symbolic object placed in the center. In half of the cases the target stimulus was set in the form of words, in other cases it was shown in the form of accurate copies of the searched image, but done in a gray color (Format of the target stimulus Factor). We recorded search time and eye movement data. Eye movements were sampled monocularly at 250 Hz using SMI iView X RED 4 (FireWire) tracking system with on-line detection of saccades and fixations and a spatial accuracy $<0.5°$.

The results of the study showed that the Chromaticity Factor had no significant influence on either search time or eye movements parameters. On the contrary, the format of presentation of the stimulus not only led to significant changes in search time, but also significantly altered the indicators of oculomotor activity. In case the target stimuli was set by a word the search took more time (mean time $\sim$ 2 sec.) compared to picture-based search. Moreover, in case the target stimuli was set by a word, relatively long fixations and short slow saccades were observed. When the test stimulus was set by a picture, shorter fixations and longer faster saccades were observed. Besides, a significant interaction between the two factors was found. The color played the role of a distraction factor in those cases when the target stimulus was set by a word and, by contrast, accelerated the search and decision process when the target was set as an image. In general, this is consistent with the results of other research that studies the influence of low and high level factors on the control of eye movements[2].

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Division of attention between the average size and numerosity of multiple objects

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A number of studies of the past 15–20 years have established that people are quite good at rapid judgments of global statistical properties of multiple objects presented briefly. Such statistical properties, also known as ensemble summary statistics, include an approximate number (numerosity), a mean along numerous dimensions (size, orientation, brightness, color, speed, even facial expression), and variance. Ensemble summary statistics are prone to selective adaptation like many basic sensory properties[1,2]; that implies that they are encoded directly by the visual system.

It also has been shown that observers are able to rapidly encode multiple objects as one ensemble, and also to divide attention between several (at least two) ensembles. For example, they are almost perfect at dividing attention between average sizes[3] or numerosities[4] of two overlapping sets. At the same time, people show some cost in dividing attention between different statistical properties such as the average size and the average speed[5].

In our study, we tested dividing attention between the average and numerosity. Regular statistics suggest that the number is used as the denominator in average calculation. If the average in vision is calculated in a similar way, then the division of attention between the number and the average should yield no cost for estimating both as compared to focusing attention on either of them. Moreover, the precision of averaging and number estimation should be positively correlated. We tested these predictions in three experiments. In Experiment 1, we presented observers with circles varying in size and number and asked to adjust the average size or type the number when the relevant parameter was precued (focused attention) or postcued (divided attention). We also studied if there is a cost of dividing attention between the average size of one set and the numerosity of another (Experiment 2) as compared to the same parameter of two sets (Experiment 3). We found no cost of dividing attention between different parameters of the same set (Experiment 1), but there were some costs of dividing attention between two sets rather than between two parameters. We also found very high precue-postcue correlations within each parameter (r=0.75–0.94) but no correlation between the average and numerosity. Together, good division of attention between two parameters and their poor correlation show the parallel and relatively independent character of visual averaging and numerosity estimation. This finding does not conform to intuition from regular statistics and suggests that the visual system calculates the average without any reference to the number as a denominator.

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How Illusions Change Sensory Thresholds

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Detection and discrimination thresholds are influenced by different factors, such as the intensity of the stimulus, the sensitivity of the observer, motivation, learning, etc.[1,2,3] All these factors can explain the fluctuation of the threshold in different trials. But what if we have the stimulus of the same size in the same trial, and find a difference in the thresholds?

3 experiments were carried out:

1st experiment. A black picture of the Necker cube on white background was used. There was a white dot on one of the lines of the cube. The line looked like "front line" or "back line", it depended on the interpretation of the cube; the subject had to detect the white dot on the line. Method of limits and method of constant stimuli were used.

2nd experiment. Modifications of the Delboeuf illusion and the Ebbinghaus–Titchener illusion were used: the inner circles were changed to the dots. The threshold of detecting the inner dots in the Delboeuf and Ebbinghaus–Titchener illusions was recorded (method of limits).

3rd experiment. The influence of the Ponzo illusion on the process of detecting the stimuli was studied. The modification of the Ponzo illusion represented 3 men depicted on a sheet of paper in perspective from left to right. The stimuli were the buttons on the men's coats. The buttons had square shape, and there was a gap in each button (like the Landolt rings). The gap could be located on the top, on the left, right or down side of the button. The subject had to detect, where the gap in the button was.

In the 1st experiment the thresholds of detecting were different for the stimulus on the "front" line and on the "back" line. The threshold for the stimulus on the "back" line was higher than the threshold for the stimulus on the "front" line (Wilcoxon Rank-Sum test, $p<0,01$).[4]

In the 2nd experiment the threshold of detecting the stimulus in the big circle was higher than the threshold of detecting the stimulus in the small one (Wilcoxon Rank-Sum test, $p<0,05$).

The 3rd experiment: if the button was located on the "front" man the threshold of detecting the stimulus was higher than on the "back" man (the former seemed to be bigger) (Wilcoxon Rank-Sum test, $p<0,01$).

The experiments show that for the sensory system, physical characteristics of the stimulus are not enough to describe the process of detecting the stimuli. These stimuli were the same (the same size, the same demonstration at the same time), but the results of their detection were different, because the interpretation of the size was different. It suggests that the size of the stimuli, the sensitivity of the observer, his or her motivation and other factors, which are usually mentioned in psychophysics, are not enough to describe the process of detecting a stimulus. Equal stimuli at the same time can provide different sensory threshold due to different interpretation of their size. An explanation can be found in categorical perception research[5,6]. The discrimination of two stimuli depends on the category of the stimuli (the same or different). We suggest that illusion makes the observer put two equal stimuli in two different categories (close–far, big–small), thus leading to different sensory thresholds.

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The Insight as a psychophysical threshold effect which connects cognitive and emotional components

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The Insight phenomenon is a crucial for the problem solving. The pioneers of the Gestalt psychology in 20-s suggest that insight depends on fundamentally changes of the relationships between the parts of a context. The problem, according to this approach, consists just in formulation (mental modeling) the new relationships which permit to solve the problem. The changes of relationships depends on the restructuring, usually evoked by sudden perceptual transformation of the parts of a context. The classical 9 dot matrix model of Insight strongly depends on the instruction we give to an observer or on his/her internal strength to follow the instruction. The instruction which consist the words "…connect the dots…" make impossible solving of the problem if this instruction will not be broken by participant. The solving is possible and rater essay to most participants if instruction includes the words "…pass the dots, by the line". The next Gestalt perceptual effect of dot matrix grouping – perceiving the lines or the columns in dot matrix – as well is related to the task but much less. It works automatically like the perception of ambiguous figures, such as the Necker cube effect, and, practically, don't depend on training. Both traditional tests for insight demonstration, as the 9 dot matrix test and ambiguous column versus line in dot matrix effect strongly depend on recombination process. On the contrary to recombination approach, we proposed to investigate and measure the insight as the threshold process. This permits us to resolve only one of many mechanisms of Insight but very important. We return Insight phenomenon to psychophysics, and Fechner law including measuring of internal noise of a subject's brain. Water level in Archimedes bath is a wonderful example of such approach. In ordinary spatial vision this experiments cane be provide by measuring the threshold of figures minimal completeness, or maximal incompleteness, but sufficient for this figure recognition. To achieve this aim of our work we use computer version of Golin Test[1]. This is well-known method of measuring the perception thresholds of fragmented images. We explore it for solving the problem of evaluating the characteristics of insight in a mind. We operate the optical properties of incomplete images and measure the psychophysical recognition thresholds of this test objects. This is necessary conditions for the appearance of visual insight. The emotional part of aga-effect is very important to clarified the threshold as insight. The emotion reaction was estimated by conventional subjective tests and by objective measurement of physiological emotional reaction by measuring eye movements, pupil size, and provide the EEG and EMG recordings. The architecture of the neural networks and brain area interconnection ensure the appearance of insight that is considered using results of fMRI and EEG measurements. The threshold of incomplete image recognition in noisy background is supported by subjective reaction (aga-effect) and physiological measurements which demonstrate a statistically significant emotional response after decision. The visibility of 20% of test image is enough to mental integrate visible fragments into whole objects independently that 80% are invisible. This effect of visibility is correlated with general Paretoprinciple[1] and is impaired at schizophrenia patients[2].

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DEVELOPMENTAL AND ANIMAL PSYCHOPHYSICS

A problem of Mind genesis and sensitivity appearance as a criterion of Mind origin: elaboration in Russian psychology

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A problem: what is Mind and what is its elementary form appears necessary when early genetic mental forms are studied. In Russian psychology Mind is defined to be a kind of reflection: a living organisms ability to reflect external and internal reality via their own states given them in a subjective form (see[1]). Thus, Mind has its specificity as compared with another kinds of reflection existing in nature. It is a peculiarity of the reflection quality: this reflection is presented to a subject (S) by his (her, its) own states. A simple sensation is an elementary origin form of such states.

A definition of sensation was included into conceptions of antic philosophers (Epicure, Aristotle), H. Hegel's philosophy system; it was underlined by G. Spenser, I. Sechenov and was accepted to be Mind existence objective criterion by A. N. Leontiev. Sensation was defined as a specific ability of animals to feel environment influences. This ability appears from an irritability which is a general property of all living organisms. Hegel described an essential character of subjectivity as a living organism ability to find itself in its own body, to feel it's own wholeness in a specific form. Hegel defined this ability as sensitivity. Having a mental reflection, a S has an object (O) to him(her, it)self in a form of an elementary mental image (a simple sensation) before an interaction beginning with this O or avoiding it. This idea of sensitivity was accepted by A. N. Leontiev to be the main idea of his theory of Mind evolution.

Hence, this internal feeling belongs to the S him(her, it)self and can't be discovered directly. That is why a problem appeared: to search for external objective criteria of Mind which may give evidences of the sensation existing. In Spenser's and Sechenov's works the simple sensation is considered to be a unit of Mind which has been developed from the irritability of low level living organisms and then has been transformed into higher level mental manifestations. Spenser considered a Mind development mechanism as changes of interrelations between an organism and an environment which stimulated by the environment changes. Mind function is to adjust internal relations to external ones. Therefore psychology has to study these objective relations between the S having Mind and the environment. A. N. Leontiev has formulated an idea of S–O interaction features correspondence to a content of his (her, its) mental reflection. This content itself belongs to the S but it may be discovered in a study of its interaction with the O because the S's object activity is built on the base of this reflection. Leontiev used the object activity as a unit of Mind analysis and considered it to be directed to S's requirements satisfaction. The elementary form of Mind (the simple sensation) corresponds to the elementary form of S–O interaction. This interaction is manifested as a simple reaction to an environment simple factor which carries out a signal function but not an utility one. It is a function of the S's orientation regarding to a biologically significant O. This function is realized on the base of changes which arise in the S's states because of the mentioned factor influences. A sensitivity was considered as a reaction to the signal environment factor but not to the biotic one and was accepted to be such the external criterion for which Leontiev searched.

Leontiev has modeled an experiment which has shown a person's light sensitivity appearance in a form of a simple sensation. Due to these studies Mind development stages has been distinguished in ontogenesis then.

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Two Types of Natural Psychological Organization: on Sensitivity as a Criterion of Psyche

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75 years ago Alexey Leontiev proposed the criterion of the psyche-sensitivity, i. e. the ability of living systems to respond to the environmental signal factors that are not directly used for the purpose of constructive metabolism and do not harm the organism[1]. However, current evidence suggests that this criterion is not sufficient given the fact that it makes no provision for differentiation and may be found in any organism. In addition, such pivotal properties of the psyche as subjectiveness (initiative, agency) and subjectivity (the individualized relation with the environment) are indispensable attributes of any living system.

To solve this problem, we suggest using a combination of three functional criteria: the cognitive function, the agency control function and the communicative function. This approach allows one to distinguish between two forms of the psyche, i. e. the proto- and the eupsyche.

The protopsyche characterizes mainly "subjective" orientation within an organism, or a community of cells, with no differentiation between physiological and psychological processes at this level, providing the three functions specified above as criteria. At this level, organisms use identical signals for the regulation of their internal processes, for orientation in the surrounding space and for communication with other living systems. It should be emphasized that one can ascertain the existence of the protopsyche only in the system that is characterized by the presence of all three functional criteria, since individually they may be identified even in inanimate objects. Only living systems meet this requirement in Earth conditions.

At the next level, the eupsyche, the above-mentioned criteria are meant to characterize regulation of a specific form of agency, the behavior, which leads to differentiation between the signals used within the body and those used between the body and the external environment. Accordingly, the subjective orientation now occurs mostly in the environment, not inside the body.

The three functional criteria of the eupsyche are: holozoic nutrition, animal motion and sensitivity. The holozoic type of nutrition is characterized by the capture and intake of solid particles by an organism, or cell, to digest them producing a soluble substance. Holozoic nutrition presupposes the development of specific animal-like motion, including locomotion and manipulation. In the course of their evolution, animals have relied primarily on the development of locomotor and manipulative organs for holozoic nutrition. Hence sensitivity (according to Leontiev) provides the orientation of animal movement for holozoic nutrition. Living beings possessing eupsyche must meet all three of the above-mentioned functional criteria.

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Body schema as a system of multiple sensory modalities: a comparative aspect

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Body schema is a set of motor skills and abilities that enable different movements, as well as awareness of the physical characteristics of the body (limits, weight, current position of limbs, etc.). Primate body schema is a complex psychological system formed by integrating signals of multiple sensory modalities, primarily visual and kinesthetic. It can be flexibly modified by the subject by incorporating various external objects used as tools[1].

Our research shows that in other animals body schemata have different degrees of complexity and sensory content. The animals we studied were representatives of gastropods, arthropods, rats, snakes and lizards.

Laboratory experiments were the main method of obtaining empirical data, during which we studied the effect of changes in the physical parameters of an animal body on the behavior in the different experimental setups (maze or problem box). Initially, the animals were placed in the experimental setup sometime before the experiment so that they were able to adapt to the experimental conditions and form skills in various types of behavior: feeding and avoidance of negative stimulation by penetrating through the holes of different size. Next, the body limits of animals of the experimental groups were expanded. As a result, the animals had to develop a new skill, i. e. finding the holes large enough for their modified bodies. For the second group, on the contrary, the physical parameters of the environment were changed (not the limits of their bodies): the hole through which they had learned to feed or escape previously was made too small. After the formation of a new skill in the changed conditions (modified boundaries of the body or the environment parameters), the experimental pattern in both groups was interchanged to see whether the animals were able to transfer previously acquired experience to new situations.

The results thus obtained suggest that invertebrates miss a body schema as a permanent independent cognitive structure: it is formed as a situational element of a holistic reflection of the situation. In these animals the reflection of the body is sensory, but not perceptual, i. e. it is based on the sensory signals of a specific modality originating from a particular body part. For example, in arthropods sensory signals from the antennae are crucial.

Reptiles can gradually rebuilt their body schema (a type of learning), and their behavior is much more rigid than that of mammals. The study shows that in vertebrates a key role in the construction of the body schema is played by kinesthetic and olfactory, but not visual modality.

The rodents may quickly modify their body schema (through just one or a few trials). This allows them to effectively plan their own behavior and to anticipate the consequences of interaction of their body with the objects in the environment.

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Ultra-low doses of different biologically active substances regulate neuronal functional states

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An organism obtains environmental information by means of a system of senses. By definition, psychophysics studies interaction between objectively measurable physical processes and feelings experienced by the subject. Objective measurements of the activity of biological substances in relation to operating incentives show that it is considerably more sensitive than the subject is able to report. At ultra-low intensity, nonspecific properties of usual agents emerge. A typical feature of any biological system is the nonlinearity of response to an increasing influence – a so-called "dose–effect" curve. Recently, it has been shown that the dependence between the parameters of influence and the response can be bimodal: the effect increases as the influence reduces, then, in the process of further reduction of the acting substance, the response decreases, after that it is replaced by a dead zone, and later, as the intensity of influence keeps lowering, the response grows again. This relation has been proved valid for physical factors and chemical substances[1]. Our experiments were conducted on a semi-intact preparation of a mollusk Helix lucorum and isolated neurons of nervous system with the use of several biologically active substances: two kinds of synthetic antioxidant, GABA, ethanol, acetylcholine, serotonin, DSIP (delta-sleep inducing peptide), antibiotic ruboxil, nootropic GVS-111 and ethanol. The isolated neurons were placed into a special chamber. All the substances (0.35 ml) were introduced into the chamber in single dosing, mixed with normal saline in concentration 10^{-3}–10^{-27}M. The following characteristics were checked: the level of membrane resting potential (MP), the electroexcitable membrane and pacemaker mechanism, chemical sensitivity of somatic membrane loci to neurotransmitter acetylcholine (Ach). The results demonstrated that all the substances initiated the development of prolonged neurophysiological responses. Within the contact interval, the intensities of neuronal reactions do not depend on the concentration and type of substance. Our experiments within the concentration range of 10^{-3}M–10^{-27}M reveal multiple dependencies of a dose effect on various substances. Each dependency shows an individual form of neuronal response to a certain substance. It means that the results will vary depending on acting substances so far as the neural systems responding to this influence show a certain form of behavior.

The studies of the effect of ultra-low doses of chemical and physical factors on living substance illustrate the fundamental behavior-regulating role of agents that remain unnoticed by the subject (especially if the subject is human). In order to understand what regulates a person's behavior, we must expand the borders of psychophysical research beyond the limits of awareness.

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Assessment of early mechanisms in sensation and perception: what do we know so far about infants?

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This review aims to present the state-of-the-art of the research field for sensation and perception in the first year of life with emphasis on methodological improvements and challenges. The boom of Babylabs openings marked the beginning of the new millennium and has been producing a huge amount of data exploring intermodal sensory-perception relations and its relation to language, cognition and social-emotional development. Nowadays, we know that infants have a complex learning system dependent on nutritional, genetic (epigenetic) and social interaction variables, among others[1,2]. Before enquire about how sensation and perception mechanisms interact and evolve as we develop, we must first know what kind of perceptual capacities we had at birth. Unfortunately, newborn babies are difficult to test…[3]. Neonate babies sleep most of the time, do not meet the instructions, and do not respond to our questions in a direct and verbal form. They also produce a limited set of observable responses[1,2]. This requires experiments to be totally creative in predicting perceptual skills measures of very young human and ensure that what is being measured is to be measured. Moreover, the development in the first year of life changes rapidly and may require the use of different techniques each month of life that can produce results that are not comparable. To try to resolve these inconsistencies, researchers may be forced to use animal models instead of humans, especially if operating physiological measurements are required[1]. Research with babies may need to also involve hospital environments (e. g., fMRI setting), high-cost laboratories where sophisticated and elaborate equipment will be "hung on hooks and tight and temporary environments". There is also the need for the cooperation of parents who are still recovering from childbirth or adjusting to a new family dynamics[3]. During the experiments it can take sometimes hours until the baby can be tested in an alert and calm state or deal with the inevitable baby's condition changes after the testing has begun. The key to measure the perception of a baby is to propose the right question, for instance: Instead of asking "What you see", ask "Can you tell me the difference between stimulation of left and right?"[3]. Current methodological challenges involve studies with special samples as premature babies, with genetic alterations (e. g., Down syndrome) or neurological disorders[1]. Among the sensory modalities, the perception of pain in infants is the one that presents the greatest challenges. The recognition of pain expression in newborn differs widely from adults in both methods and the type of expected response, and a complex of physiological and behavioural measures are suggested[4].

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Skin conductance activity components react differently for pain perception and distress in newborn infants

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Skin conductance activity (SCA) algesimeter has been used as a tool for pain perception investigation in non-verbal subjects as anesthetized patients and very young infants[1]. It can be divided into three main parameters as number of waves in seconds, area under curve and average peak, all comparing three periods: baseline, during nociceptive stimulation and recovery. Another aspect of pain perception is the ability of the brain to modulate the body reaction to pain also known as habituation to pain, a supposed mechanism to support a healthy balance between nociceptive and antinociceptive mechanisms that protect against chronic pain states. It happens when constantly sensitized nociceptors undergo a functional plasticity capable of activating brain areas that inhibit the pain response[2,3]. However, little is known about this ability in infants. The goal of this study was to observe the pattern of the three SCA components in a habituation paradigm testing to pain in neonates by means of a comparative analysis of behavioural and physiological parameters and the effect of maternal stress over their response. This was an observational study, controlled by the individual, before and during nociceptive stimulation of 14 healthy newborns that underwent four heel lances for blood glucose curve. Habituation to pain was investigated through (1) behavioural scales, observational Visual Analogue Scale (VAS) and Neonatal Facial Coding System (NFCS), and (2) physiological parameters: average peak, number of waves and area under curve obtained by SCA; heart rate and O_2 saturation variability; and salivary cortisol. Among all measures, the behavioral scales and average peak component of SCA during 15 seconds of the lance proved to be sensitive to change between baseline and during heel lance for all trials showing evidence for pain perception. Area under curve component of SCA had a late reaction and showed higher levels of response around 30 and 180 seconds after lance with a high level of response at second trial and no reaction at third and fourth trials. VAS scale and number of waves per second component of SCA differently continued to react to lance increasing the intensity of response and giving evidence for sensitization. To analyse the response over trials a repeated-measures ANOVA was run and a significant effect of decay to lance over time for average peak response was observed, $F(3, 1.540)=21.960$, $p<0.001$, also for NFCS scale, $F(3, 2.146)=4.218$, $p<0.018$. Infants differed in levels of stress measured by salivary cortisol, $F(3, 1.540)=5.273$, $p<0.041$, for average peak register. In conclusion, reaction to pain stimulation was continuously successful registered over time by behavioural scales and SCA, though the pain habituation was observed only by NFCS scale and SCA suggesting that a more detailed factorial scale and the average peak parameter of SCA are sensitive tools for pain studies in infants in habituation paradigm and maybe related to memory building of the repetitive skin stimulation. VAS scale, an observational single factor measure, and number of waves per second gave evidence for sensitization over time and may be linked to stress reaction, what was linked to environmental stress while the late component registered by area under curve maybe linked to an emotional response only presented in the two first stimuli trials what could be hypothetized as distress.

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Reduced spatial suppression and enhanced spatial summation in visual motion processing of ASD children

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Spatial integration of visual motion signals with increasing stimulus size critically depends on stimulus contrast, with spatial suppression (SSUP) dominating at high contrast stimuli and spatial summation (SSUM) having the greatest impact at low contrasts. Although perception of motion is atypical in Autism Spectrum Disorders (ASDs), the SSUP and SSUM has not been thoroughly studied in this population, except of one study[1], which employed exceptionally high IQ children. Since local inhibition in the primary visual cortex plays a fundamental role in contextual modulation of visual motion processing[2] and considering evidence for abnormal inhibitory circuitry in ASD[3], we hypothesized that both SSUP and SSUM may be atypical in this clinical population.

SSUP and SSUM were examined in 32 ASD and 41 typically developing (TD) boys aged 6.8–15.5 years. The stimuli were vertical sine wave gratings (1 cpd) drifted at velocity 4 degree per second. The gratings had either small (2°) or big (24°) angular size and were presented at either high (100%) or low (1%) contrast. Participants judged direction of the motion while duration of the stimulus presentation was adjusted on the trial-to-trial basis using interleaved one up – two down staircases. ANOVA analysis was performed for log-transformed detection thresholds separately for low and high contrast stimuli.

As expected, with increasing stimulus size the motion perception deteriorated in the high contrast condition (SSUP), but improved in the low contrast condition (SSUM). There were significant group interactions both for high and low contrast conditions: *SSUP was atypically reduced* ($F_{(1,71)}=4.70$, $p=0.034$), while *SSUM was atypically enhanced* in the ASD group ($F_{(1,71)}=8.93$, $p=0.004$). Whereas the degree of spatial suppression increased with age in the TD boys, in boys with ASD the SSUP exhibited the opposite age trend accompanied by a reliable age-related increase in spatial summation. In the ASD group the strength of SSUM in perceiving motion direction correlated with severity of ASD symptomatology, but not with IQ scores.

The opposite direction of SSUP and SSUM abnormalities in children with ASD may be explained by weakening of center-surround inhibition at the level of primary visual cortex due to abnormally low excitability of the local inhibitory circuitry. Such a deficiency in excitability of local inhibitory connection may reduce perceptual disadvantage of large, high-contrast moving stimuli and at the same time enhance perceptual advantage for low-contrast stimuli of a bigger size. Different developmental courses of SSUP and SSUM in ASD and TD individuals across childhood and adolescence suggest atypical enhancement of the facilitation and sensitization to moving stimuli with age in ASD children.

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The importance of vestibular input and the environment to early child development as determined through psychophysical principles

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Adaptation to the gravitational vector must be considered in the ecology of early child development. Proprioceptive/vestibular interactions occur as early as the first synapse in the brain. This interaction, is a critical catalyst to the proper development and functioning, required for efficient learning and movement ability. The recent rise of sensory processing issues coinciding with demands for STEM literacy requires us to consider how recent cultural changes have impacted a child's natural experience within the gravitational vector and how changes driven by this interaction may be impacting the quality of future learning and movement ability. Viewing human development through the lens of psychophysical principles will illustrate the critical impact gravity has upon optimal sensory system function and physical development.

We will present a psychophysical model that demonstrates how gravity profoundly affects the form and function of human development. Sensory systems require gravity to function optimally and have critical periods for development. Core motor, sensory, perception and cognitive systems are in place and develop relatively rapidly after birth. Through a complex choreography of quantity and quality of experiences within the gravity vector a human develops the sensory processing systems necessary for efficiently navigating the psychosensory field and body field. Analyzing human development utilizing our knowledge of neural navigation architecture, planes of space, axis of motion and haptic awareness we can employ a psychophysical model providing a new platform for observing, measuring and analyzing human development.

Technological and medical advancements and an increasingly mobile society is affecting the natural trajectory of human development. Screen time replacing physical play, infants sleeping on backs instead of in prone, and restrictive devices including car seats all limit a child's mobility within the gravity vector. Repetition and intensity of stimuli is required for stabilizing neural pathways and hopefully reducing unnecessary redundant information. A lack of sufficient duration and intensity of biologic system experience within the gravity vector plausibly contributes to the rise in sensory processing and integration disorders, including dyslexias, attention deficit disorders and autism, conditions where information may be overwhelming and the child unable to inhibit the redundant information.

Psychophysical science is based upon the assumption that a quantitative relationship exists between environmental stimuli and sensory perception. Extending traditional Fechnarian principles to include the gravity vector and the development of biologic systems a new psychophysical model can be realized. This model presents the opportunity for new assessments, interventions, technologies and programs to address the rise in sensory processing issues and prepare young minds to thrive in a changing world demanding STEM literacy.

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Different processing of Navon figures in children with normal reading skills compared to children with poor reading abilities

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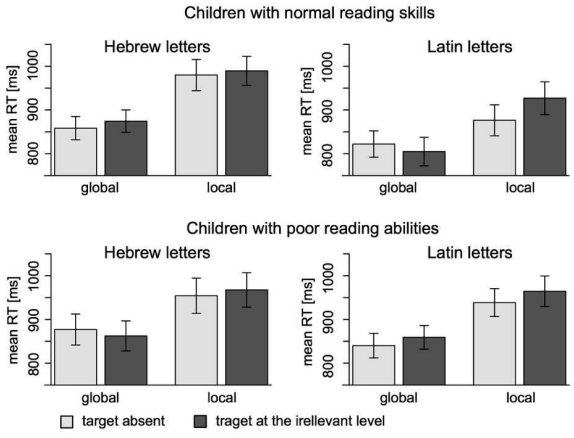
A number of studies demonstrated, that children develop specific letter processing strategies during reading acquisition. However, children diagnosed with developmental dyslexia seem to maintain their earlier developed object recognition strategies also for letters[1].

Navon figures are compound, hierarchical figures with a global and a local structure (e.g. a large "A" build-up of small "A"'s). Paradigms using these Navon figures lead to the Global Precedence Effect (GPE), meaning that the global level is processed faster than the local level (global advantage) and the global level influences the processing of the local elements but not vice versa (asymmetric congruence). The presence of the GPE seems to differentiate for letters and non-letter shapes[2].

In this study, we compare these kind of stimuli for children diagnosed with developmental dyslexia and children with normal reading skills, to figure out, if the groups use different processing strategies also in this kind of stimuli.

Participants were advised to detect a target either in the global or the local level of Navon figures, which consist of well-known Latin letters or Hebrew letters, matching the Latin letters in their visual features, but correspond to unknown non-letter shapes for German elementary school children. Children with normal reading skills showed a GPE for Latin, but not for Hebrew letters, whereas the dyslexic group showed no GPE for both kind of stimuli (see Figure). These results suggest, that dyslexic children are not able to access the same automatized letter processing strategy as children with normal reading skills properly.



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PSYCHOPHYSICS AND NEUROSCIENCE

Perceptual illusion and sensitivity of sensory system

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The independent component analysis of natural stimuli shows that there are independent stimuli sets, which are characterized by independent features as colour (light spectra), stripe orientation, direction and speed of movement, location of stimuli in space and so on. Moreover, values of each feature form a set consisting of large number of independent elements. However a dimension of subjective space of features is not large. It is known that in the brain there are special neuron sets tuned to specified value of feature (color, stripe inclination, movement direction etc.). Each of these neurons, called neuron-detector is excited more than other neurons when the stimulus has a certain color (e. g. red), or it is tilted at a certain angle. If perceiving of feature is determined by the activities of detectors, then a dimension of set of detectors could coincide with the dimension of the subjective space. We assume that among the set of detectors there is a small number of independent neurons. We call these neurons the cardinal detectors (CD). Responses of CDs determine the components of vector. Other neuron-detectors linearly sum up with some weights of the CD's responses. Weights of detectors are chosen in such a way that the given detector is maximally excited (higher than other detectors) at a given value of the feature of the stimulus. The absolute value of response is not important and it depends on modulus of vector. Thus features are coded only by orientation of vector, i. e. features are coded by a point on the unit sphere, where the vector intersect the unit sphere. We suggest the responses of the CDs are chosen the way that the area on which stimuli are mapped would be as large as possible. The resolution of the proposed model (just noticed differences in feature values of two stimuli) depends on the angle either between two vectors coding features (color, contrast, inclination, location in the space) of two stimuli presented simultaneously or two stimuli presented sequentially in time. We assume that the sensitivity of CDs to a stimulus feature is not constant, it is modified depending on stimulus situation. The sensitivity of CDs is modified so that the resolution of the system for given features is increased. It is shown that both the so called simultaneous contrast illusions (increasing contrast, expansion of acute angles between two stimuli, inclination and movement direction, etc.) and illusions resulting in long-term observation of the stimulus or adaption (normalization phenomena and adaptation after-effect) stem from the modification of the sensitivity of the CDs. It should be noted that increasing resolution for some stimuli means that an area of sphere on which they are mapped is enlarged (stretched). But as the whole mapped area is fixed, the enlargement of one part of sphere arise the shrinking the other part of the sphere surface.

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The spherical model of semantic structure of the emotion names, based on subjective differences

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Functional relationship between emotional content of terms and their perceived semantic differences remains poorly studied issue. In this paper vector model in the form of a spherical 6-dimensional Euclidean space is proposed to describe the semantic structure of emotion names. Averaged on a sample of 152 respondents matrix of semantic differences between the names of six basic emotions and their synonyms and denotation of a neutral state is served as the material. Using ALSCAL procedure the spherical 6-dimensional space is constructed in which Euclidean distances between points-words lying on a spherical surface coincide with the corresponding semantic differences.

Three circular semantic structures – valence, intensity, power – are constructed. Each circular semantic structure is represented in the model space by separate plane formed by the combination of two axes – the leading one and supporting one. The leading axes – "happy/sad", "activation", "surprise/fear" give a rough linear separation of words in terms of listed parameters. Adding supporting axes – "fear/angry", "neutrality", "angry/disgust" – implies more differentiated circular parameters whose values are the polar coordinates. Circular order "happy–surprise–fear–sad–disgus–angry–happy" in terms of "valence" provides a precise separation of the words in categorical groups; each group includes the name of the basic emotions and its synonyms. Distribution of synonyms on the plane "valence" have a different character. The emotional content of one part of the synonyms is determined through the content of the relevant name of basic emotions (for example, "outrage", "disturbance" as the degree of "anger"). The emotional content of another part of the synonyms is defined through different contributions of content of names of adjacent basic emotions ("admiration", "delight" through "happy" and "surprise"). Circular order "happy–sad–surprise–fear–angry–disgust" on energetic parameter "intensity" divides the names of emotions into groups on the level of intensity from low to high values. Synonyms of such names of basic emotions as "sad", "fear", "angry", "surprise" grouped next to the names of relevant basic emotions get close value to it by the intensity. Synonyms of such names of basic emotions as "happy", "disgust" are distributed on different levels of intensity. This allows to denote homogeneous and heterogeneous categorical groups of names of emotions on intensity parameter. Circular order "fear–disgust–surprise–sad–happy–angry" on energetic parameter "power" divides the names of emotions into groups on the level of power from low to high values. Homogeneous ("surprise", "sad", "happy", "angry") and heterogeneous ("fear", "disgust") categorical groups in terms of "power" are allocated through the distribution of synonyms with respect to the names of basic emotions. The observed association of words into the groups and division groups between each other on circular semantic structures are explained from the standpoint of spherical neuropsychological model of emotional and cognitive processes by prof. E. N. Sokolov.

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The Development of Vector Coding the Imaginative Information in the Brain

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1. In this pilot study for azimuth analysis of a topologically represented scale signal mapped from its neural imprint in the long-term memory E. N. Sokolov's[1] vector psychophysiology unit was used. The instrument check-scale signal poses a real problem if it appears as the trace of the subject's movement trajectory. The registration signal cannot have linear signal parameters but must be presented as a topological figure.
2. The hypothesis of an azimuth network[1] and not a graph[2] nature of topological coding of scale signals in the brain is suggested. The recognition in the path of such an element as a cognitive motive (as a vector) allows us to convert a three-dimension topological signal into a linear one-dimensional one: a chain of motives, a chain of cognitive gestures, a chain of sequences and a relay circuit of commanding neurons (according to Sokolov). The USC mathematical apparatus can be further applied to the one-dimension signal for formalization of the cognitive gesture chain. The presentation of different trajectories in USC allows us to compare them metrically with each other. The metric similarity/dissimilarity of different routes of cognitive objects, introduced through vector psychophysiology, allows to metrize the similarity/dissimilarity of the inspection meaning.
3. We have carried out experiments on the "circular examination map" registration of a 3D object in a virtual reality environment. The rotation technique of a virtual test object with the use of a virtual reality glove stereo display on the screen in reverse visual feedback was used. The motivational areas of the circular trajectory examination were recognized[3]. The coordinates on the gaze route, the gaze direction vector, the movement speed, the coordinates of "the points of interest", the psychometric data of the subject's cognitive reflexes appeared to be the parameters for their recognition.
4. The extent of the dissimilarity between one route and the other can be understood as the extent of anthropological closeness of two actions in the psychological practice of an individual: motivational, goal-setting, individuality-oriented. Thus, the extent of the closeness of two topological routes can be indirectly evaluated taking into account the similarity of a number of "gestures" of the so-called involved "command/major neurons".

   The extent of the pairwise similarity of the gestures was additionally assigned by the matrix of mutual similarity of gestures. The matrix was developed experimentally, according to the frequency of erratic substitution one gesture for another in the sessions of the subject managing the exoskeleton's movements, observed through EEG. At present visualization of the topology of the route(s) is becoming possible thanks to micro fMRI of motor areas in the interactive way.
5. The final model. The circular rotation routes of an object, executed by hand, are copied and preserved in the brain in the form of topological-shape neural routes. These routes follow the topology of the external routes and are stored in three-dimensional space of anatomically dispersed brain neurons. Reference points are formed in the sections of these routes, where the route makes a topologically sharp, steep curve (M. A. Kremen). In some reference points the brain adds to them "the photograph" of the external scene that the viewer had seen in reality[4]. Besides the photographs, meaningful milestones and emotional affects experienced by the observer are added to the route at these reference points[5].

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The violation of the anticipation processes is the early markers of Parkinson's disease

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Background: The purpose of this study to identify the cognitive processes in two groups of patients with Parkinson's disease with different levels of violations. The cognitive processes of patients are compared with two control groups of different age. The attention was directed to the mechanism of anticipation as a special kind of memory and the mechanism of semantic categorization. The experiment included the identification of semantic categories during the visual presented of words belonging to two domains: "animals" and "objects". Categories of "animals" demanded one motor reaction and categories "objects" – two motor reactions.

Methods: The author's method "Micro structural analysis of oscillatory brain activity"[1], which is based on the pacemaker hypothesis of the rhythm genesis, was used to study the cognitive disorders in patients with Parkinson's disease (PD). The method includes the multi-channel EEG and calculation of equivalent current dipoles for narrowband frequency-selective generators extracted from the evoked potentials. The first group of patients (11 people: 4 males and 7 females, 64–79 years old) with stage of disease 1 and 3 upon Hoehn-Yahr has received the drug – L-dopa alone. The second group of patients with more early stage of PD (11 people: 6 males and 5 females, 47–68 years old) with stage of disease 1 and 2 upon Hoehn-Yahr has received ADR (agonists of dopamine receptors). Results obtained from the patients were compared with two control groups: young (10 people:5 males and 5 females, 22-23years old) and older (10 people: 5 males and 5 females, 50–60 years old).

Results: An increase of latent periods of motor responses, the number of errors and the suppression of frequency-selective theta generators activity occurs in both groups of patients when they recognize the category of "animals". The identification of the category – "animals" is the simple task for the norm groups than for the patients. These changes occur before stimulus in the stage of the anticipation. The group of patients taking the drug L-dopa, has the best performance to Theta generators at the stage of identification of the category – "animals" than patients at an earlier stage of the disease and who has received only agonists dopamine receptors.

Conclusions: Violation in anticipation makes it possible to consider this mechanism as an early marker of Parkinson's disease[1].

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Positive, negative and neutral feedback processing in speech-nonspeech discrimination task

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Previous studies revealed that in auditory learning paradigms feedback plays a major role[1,2]. Processing of prediction errors lead to different patterns of neural activities measured with functional magnetic resonance imaging (fMRI). In this study, we investigated the role of positive, negative and neutral feedback while participants were performing a speech-nonspeech discrimination task in the fMRI. The German vowels /a/ and /a:/ and their spectrally rotated counterparts as corresponding nonspeech stimuli were used. To induce task difficulty, we morphed speech and nonspeech stimuli into each other to allow a variable amount of speech and nonspeech in each stimulus. Participants were asked to judge via button press whether the presented stimulus sounds more like a speech or a nonspeech stimulus and received feedback about their performance presented as different smilies: a green happy one for correct and a red angry one for wrong answers. In 25% of the trials, they received a yellow neutral one irrespectively of their answer. Analyses of behavioral data allowed dividing participants into a group of Learner and a group of Nonlearner dependent on their psychometric function for the speech–nonspeech criterion. Reaction time analyses revealed an effect of Correctness (correct vs. false) and Speech (speech vs. nonspeech) as well as an interaction Time (1st vs 2nd half of the experiment) x Correctness x Performance (Learner vs Nonlearner) indicating that throughout the experiments, correct responses are getting faster whereas false responses are getting slower, especially in the group of Learners. Analyses of the fMRI data at the time point of sound presentation revealed an effect of Performance, Correctness and Time. However there is no difference in brain activity related to the difference between speech and nonspeech stimuli. Analyses of the fMRI data during feedback presentation also showed significant brain activity for the factors Performance and Time but also for Feedback (green vs yellow vs red). Summarizing, this study shows that depending on the different feedback, different processing strategies are used to solve the auditory discrimination paradigm.

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The thresholds of facial expression sufficient for nonverbal communication

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A human face was always a subject of grate interest in society, science and art. Last decades attention to this problem increases rapidly due to the image technological revolution[1]. The aim of our work is to investigate neuronal nets and image processing of facial expressions and facial deformations as a part of nonverbal communication. Our work deals with psychophysiological measurements of a threshold according to Fechner's equation, including measurements of internal noise. We study mechanisms of minimal facial expressions perception and architecture and activity of neural networks that work just at a threshold level which is sufficient for communication. In this case measurements of the minimal changes of the face expressions are crucial, with image processing and neuronal nets investigations for measuring a threshold of minimal facial expressions[2,3].

We carried out experiments using digital synthesis and digital processing of test pictures of faces expressed different emotions and head positions. We measured psychophysical thresholds of minimal facial expressions perception and compared it with digital face expression recognition systems[2,3]. On the next step we investigated responses of neural networks from the retina to the frontal brain using functional magnetic resonance imaging[4]. The decisions were made by the opponent neural structures, similar to the opponent mechanisms that are known in the primary levels of the visual system[4]. Our study shows the opponent relationship at the global level between the different phases of stimulation.

There is a complex system of co-working areas in the brain, each making it's specific contribution to the implementation of mental processes, and secondly that each of these brain areas may be involved into the implementation of different functions depending on instructions and experimental conditions. The functional construction of these networks creates a pattern of neural activity specific to each experimental situation. The specificity of this pattern is determined by an observer's task or a participant's aim and by physical, geometric and semantic characteristics of visual stimuli, and, finally, by structures of the eye and the visual brain, providing the perception of facial expressions[4].

Face perception allows us to study mechanisms of unconscious and conscious perception. It is important not only for theoretical but for practical work. In clinical investigations we see differences in response thresholds of normal subjects and patients with schizophrenia[5]. The authors demonstrate neural mechanisms of an observer's discrimination between face deformations which are different during communications with a friend and a foe.

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Neuronal constants in psychology

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I included two neuronal constants (F=10 Hz) and (R=0.1) into seven equations derived in a purely analytical way[1] from wave peculiarities of collective neuronal activity in human brain:

N=1/R–1=9	(1)
t(A)=0.5/(FR)∗((1–(1–R)/A)∗∗2)	(2)
H=N lg N/lg A,	(3)
p=0.5+0.5∗F(0.677/sqrt((N+1)/2))=0.618	(4)
R+R/2+R/3+…+R/M=1	(5)
S=RV+(V–RV∗(ln(RV) + 0.5772))/2	(6)
n=log(t(max)/t(min))/log(Imax/Imin)	(7)

The first constant (F) means typical frequency of alpha rhythm in human electroencephalogram. Hans Berger discovered it 90 years ago. The second one (R) means relative step like difference between the neighboring alpha frequencies. Mikhail Livanov discovered it 80 years ago. Constant (N) is the alphabet span of neural letters as well as the maximal number of different neural words in one neuronal sentence, in one-memory units. The value (1/FR)=1 sec is the maximal duration of single alpha spindle. The symbol (A) means the alphabet span of perceived stimuli. The function t(A) means the changeable part of the answer's latency of subject's response in the situation of simple or choice sensorimotor reactions (2). The symbol (H) means the capacity of short-term memory span (3). The symbol (p) expresses the so-called "golden section" by the formula (4), where F is the well-known Gaussian integral formula. The next formula (5), where M is the dictionary span, expresses the law discovered by Zipf G. K. in 1935. His constant R=0.1 coincides with Livanov's constant (R) and therefore the next fundamental law (6) is easy derived from neuronal wave peculiarities. The symbol (S) expresses the dictionary (vocabulary) span of any text, in which the total number of words is equal to (V>>M). Finally, the formula (7) allows to predict the values (n) of Steven's constant for stimuli with physical different intensity (Imin…Imax), because the latency periods (t(min), t(max)) for these stimuli are determined by the formula (2). Namely, t(min)=5 ms and t(max)=1000 ms. Here the value of 5 ms coincides with Geissler's constant[2], which is equal to 4,57 ms. This fundamental constant was obtained in purely psychological experiments.

Now psychology along with physics, chemistry and genetics has its own simple fundamental constants in a set of new laws. They help to understand and to predict human behavior with high accuracy in broad spheres of life, including some social aspects[3,4].

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FREE TALKS

Fechner and Stevens equations dilemma, its solution and a deduction

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1. Essence of the dilemma, its origin, necessity for a solution.
2. Current scope for solving the problem. Two fundamental tenets of the physical solution:
   - The discovery of detecting properties of neurons, which allows analyzing the frequency of nerve impulses transmission channel from the perspective of the theory of information transfer with spectral conversion,
   - The real usage of spectral conversion by the neural channel.
3. A brief description of the reasons for the usage of spectral conversion by the neural channel and hence construction of data transmission path, structurally and functionally congruent with the technical channel of the information transmission using spectral conversion.
4. The analysis of the Buger-Weber-Fechner law in the light of the first stage of spectral conversion (conversion of an analogue action into a sequence of impulses generated by neurons), proceeding to the Fechner equation, with its graphical representation as
$$\int_{S2}^{S1} dS / S = ln\ (S2/S1)$$
in relation to the result of nerve impulse sequence detection, which determines the place of the given equation in the course of the final stage of spectral conversion (detection).
5. The Stevens equation is considered. It is shown that the suggested equations put together provide evidence for the existence of detecting processing of nerve signals sequence, and based on the definition range of the exponent n ~0,7÷1,2 in the Stevens equation, conventional in psychophysiological practice, an S-shaped spectral conversion characteristic can be derived.
6. Analysis of the S-shaped characteristic in the area of its smallest spectral distortion. Demonstration of its key parameters in the given area: Golden Section as its "zero" reference point of the "sensation", with a grade in the "sensation" scale being^{1,2} √2, as in the note row. Thereby the issue of psychological significance of stimuli (including musical) with the Golden Ratio parameters is clarified.
7. Conclusions:
   - Fechner and Stevens equations refer to the same – detecting – place in the process of spectral conversion;
   - Thereby it is inferred that "sensation" (as a physical result of information processing performed in the channel) is the output value of the detector;
   - Unlike Stevens equation, the one proposed be Fechner for the "sensation" characteristics is that the latter is the sum of the outcomes of the former;
   - Physically the outcome of "sensation" is determined by the potency *P,* issued by the current *i* of the neuron-detector with its *r* load – input resistance of the next receiver. Accordingly: $P=i^2r$[W] corresponds to the energy dimension of sensation in the Stevens formula [W/m^2];
   - As a result the physical essence of sensation is reduced to that its representing magnitude on the detector exit iterates with some error energy (accordingly, voltage) of the entering action.

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Ceteris Paribus Laws and Conditional Universality in Human Response

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One of the basic questions met in the mathematical description of psychophysical regularities is their universality found within some restrictions imposed on the analyzed phenomena. The matter is that in studying a relationship between quantities controlled explicitly, there remain many hidden factors being outside the control and affecting the observed regularities implicitly. These factors can change in time and from person to person. The given regularities are often referred to as ceteris paribus laws (CP-laws)[1] to underline that the hidden factors either are controlled in some way by the systems themselves or their influence is weak and may be ignored. To cope with CP-laws Cartwright[2] put forward the concept of nomological machines – a fixed arrangement of components and factors that within repeated operation gives rise to the kind of regular behavior.

From this point of view I analyze the results of our experiments within virtual environment on shape recognition and color categorical perception[3], balancing overdamped inverted pendulum[4,5], and car-driving[6].

First, I demonstrate that each experimental setup can be treated as a nomological machine characterized by universal features in subjects' behavior which determine the main properties of analyzed phenomena. In particular, it is the universality of shape of psychometric functions and the shape of control parameter distributions. I call these regularities holistic CP-laws to underline that their formation is either a results of human learning or cooperative interaction in social systems.

Second, I pose a question about merging different nomological machines to create hierarchical system of theories ordered according to their universality. In physics of the inanimate world this hierarchical system is well known but for psychophysics dealing with human beings it is a challenging problem being at the initial stage of development. From this point of view I analyze the results of our experiments on inverted pendulum balancing and demonstrate that the consideration of human reaction as a subsystem with individual dynamics governed by its own laws enables us to merge the corresponding nomological machines into one, i. e., to describe the found results within two different experimental setups by one mathematical model.

Finally, I put forward the concept of effective dualism treating complex phenomena in human behavior in terms of two complementary components – objective and subjective ones – with their own dynamics and interacting with each other. Here the objective component is the external world generating stimuli for human reaction; the subjective component represents a subject's perception of these stimuli. By way of example, I discuss the notion of dynamical traps[8] proposed for describing system dynamics governed by the bounded capacity of human cognition, in particular, human intermittent control over unstable mechanical systems.

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Hidden Emotion in the Stroop Task

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Recent research[1,2] shows that emotion is involved in the simplest of perceptual tasks. For example, in the well-known Stroop task the participants identify, while timed, the ink color in which color words are printed. The Stroop effect has been considered a bulwark of purely cognitive processes in that performance is better for congruent (the word RED printed in color red) than for incongruent (RED in blue) stimuli.

In the present research, the participants were presented with the classic Stroop stimuli of color words in color and their task was to identify whether the color-word stimulus formed a congruent or an incongruent combination. Note that this task of divided attention differs from the standard Stroop task of selective attention to the ink color. Another unique feature of the study was that the participants gave affective responses to the compound: They responded "positive" to congruent combinations and "negative" to incongruent combinations in one condition, and responded via the reverse regime in the other condition. The results showed better performance in the first regime than in the second regime, indicating the involvement of emotion. In particular, performance with congruent stimuli was better using the term "positive" and that with incongruent stimuli was better using the term "negative". This result makes sense only if congruent stimuli possess a genuine positive emotional valence, whereas incongruent stimuli carry a truly negative emotional valence.

In further experiments, the task changed to that used in the standard Stroop setup, namely, classifying the ink color of the color words. Our manipulation affected the frequency with which various ink colors appeared in congruent and in incongruent combinations. It was found that an ink color was rendered positive merely by appearing in mostly congruent stimuli and was rendered negative when presented in mostly incongruent stimuli. We conclude that the Stroop conflict is a genuine emotional conflict generating negative aversive feelings expressed through longer response times.

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The identification of the basic emotional states displayed on a computer screen

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Perception and identification of human emotional states, that is the construction of an adequate sensory-perceptual image of a human being in communication, is included as one of the necessary links into human communicative activities and is also the basis for understanding the motivation, attitudes and level of sincerity of the interacting partners.

In our experiment we aimed to study the process of perception and identification of emotional states displayed on a computer screen, that is creation of sensory-perceptual image, which is adequate to the emotional state demonstrating in mediated communication.

As a stimulus material we used three-minute fragments of TV program recordings in which the main characters experienced one of the basic emotional states, according to the classification of K. Izard and G. Schlossberg[4,5]. The subjects were people with different indexes of extroversion/introversion (tested after H. J. Eysenck[1]) as the most important features of human temperament.

In the case of mediation the peculiarity of the formation of sensory-perceptual image of emotional states is that signals of the optical system of perception are available to partners unlike real communication, where the images of emotional states are also identified with acoustic and olfactory systems as well as with consideration of the proxemics and partners' boundaries of personal space.

A situation of mediation imposes certain restrictions on a person's ability to correctly identify the emotional state. One of the most suitable methods for the emotional state perception measurement is scaling. The rating scales method as a kind of the method of scores is an implementation of the rating procedure of ordinal scaling which is well known in the Psychophysics of perception[2,3].

In the research procedure of digital scaling our subjects had to assign a corresponding number to each experimental stimulus. In our case each of the 9 fragments of the videos (joy, dislike, surprise, anger, embarrassment, calmness, fear, sorrow) was presented by 7 screenshots, in all of which, on a 10-point scale (from 0 to 9 points), was evaluated the expression of the eight emotions according to the following bipolar scales: joy–euphoria; dislike–disgust; surprise–amazement; anger–rage; embarrassment–shame; calmness–indifference; fear–horror; sorrow–grief. The subjects rated each of the 63 displayed screenshots (7 screenshots of the 9 videos) on the ascending expression scale: from joy to euphoria; from dislike to disgust and so on.

We used the SPSS Statistics program (Version 21) for data processing. Given the study material was vast and comprehensive (9 videos, 7 screenshots in each plot, 2 groups of subjects, 8 basic emotions), we have therefore opted for such a type of processing as calculation of average point scores for groups.

According to the results of the comparative analysis, the groups of extroverts and introverts are significantly different statistically when evaluating the screenshots in the video "calmness" (Student's t-test $0{,}003<0{,}05$), "disgust" (U Mann–Whitney test $0{,}005<0{,}05$), "interest" (Student's t-test $0{,}007<0{,}05$), and "joy" (Student's t-test $0{,}002<0{,}05$). Extroverts give significantly higher scoring to communicative states of "joy", "dislike", "anger", "sorrow" on the relevant scales. The maximum differences in the estimates are on the relevant scale "anger–rage" for the video "anger" screenshots. Extroverts identify emotional states more accurately than introverts.

The process of emotion perception is complex in its nature and is a whole drama of understanding, differentiation and assessment of the basic emotions relationship in particular case of a human experiencing certain emotion on the screen. Extroverts have shown the greatest competence in the assessment of emotional states. We also observe a sensitivity to the emotions accompanying communication in the group of extroverts.

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Musical succession and physical motion

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A melodic line involves a note of a given pitch and duration, followed by another note of a given pitch and duration, and so on, but we often perceive such musical succession in time as movement in space. The motion of physical objects in space provides metaphors for describing, understanding, and experiencing music (e. g., musical contour "ascends" or "descends", melodic intervals involve "steps" or "leaps", etc.)[1]. The cognitive representation of musical succession has been suggested to include analogues of physical forces that influence motion of objects in the physical world; three such musical forces are musical gravity (the tendency of a note above a stable platform to descend), musical magnetism (the tendency of an unstable note to move toward a stable pitch), and musical inertia (the tendency of pitches or rhythms to continue their current pattern)[2].

Evidence of musical inertia is found in studies on musical composition, improvisation, and completion of melodic fragments, and musical inertia has been suggested to be analogous to representational momentum[2]. Properties of musical inertia and properties of representational momentum[3] are compared. Although there are several similarities (e. g., musical inertia and representational momentum are each influenced by velocity, direction, etc.), musical inertia occurs over a longer time-scale than does representational momentum, and so a hypothesis that musical inertia reflects representational momentum is rejected. Properties of other momentum-like effects, behavioral momentum and psychological momentum[4], are reviewed and compared with properties of musical inertia. It is suggested musical inertia is more closely related to momentum-like effects such as behavioral momentum and psychological momentum that operate on a longer time-scale than does representational momentum.

Musical inertia is suggested to provide a sixth form of momentum-like effect (in addition to representational, operational, attentional, behavioral, and psychological momentum[5]). As momentum is the product of mass and velocity, suggestions regarding musical analogues of mass (e. g., strength of a tonal center) and of velocity (e. g., tempo) are provided. It is suggested that momentum-like effects in music (a) are incorporated into functional architecture of music representation, (b) are consistent with findings that auditory imagery preserves structural and temporal information of auditory stimuli, (c) are consistent with involuntary musical imagery (e. g., notational audiation, earworms), (d) connect diverse findings in music perception (e. g., auditory streaming, scale illusion), (e) have implications for application of Gestalt grouping principles to musical stimuli, (f) have implications for naïve physics, and (g) connect studies of music with literatures on a wide range of human behaviors.

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Is human heading perception indifferent to object motion?

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Heading perception from optic flow is known to be biased by independently moving objects that are embedded in the flow field. Magnitude and direction of the bias depend on the object's position and motion. In psychophysical experiments that simulated forward observer motion at 1 m/s through a 3D random-dot cloud of 50 dots between 0.5–2 m from the observer, we found that an opaque square that contained 9 dots moving laterally produced a bias in the direction of object motion. In contrast, when the motions of the 9object dots in the square had the same lateral motion component, but simultaneously approached the moving observer at 1 m/s the bias was in the opposite direction. These biases occurred at all tested object positions (±5 deg and ±10 deg from the FOE). In addition, when the object contained random motion, heading bias was toward the object position.

To better understand the reasons for these biases we presented the same stimuli to the Lappe & Rauschecker (1993) model[1] of heading estimation from optic flow. This model calculates the best-matching (in a least-squares sense) self-motion parameters (heading and rotation) given a set of input flow vectors. Therefore, it can be regarded as a way to quantify the self-motion information provided by the combined flow fields of the observer motion and object motion. The model simulations matched the experimental data very well. The model reproduced the direction and magnitude of the bias in all conditions. Since the model simply pools all flow vectors for an overall match, and does not segment or separate object motion from the remaining flow field, the good match between data and model suggests that the human visual system may, likewise, simply pool all motion information for an overall heading estimate. In that sense, the bias may be the result of not accounting specifically for object motion. This strategy is simple, because it does not need elaborate segmentation. It might be sufficient for control of self-motion in natural conditions because the optic flow field is usually very large while moving objects typically cover only a small proportion of it.

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Understanding the link between dynamic and kinematic properties of collisions

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Material properties exert a dramatic influence on objects' motion. Despite this, previous research on the visual perception of collisions has been conducted using "immaterial" colliding objects as experimental stimuli (e. g., simple, colorless 2-D shapes). In the current study, we explored people's intuitive understanding of the relationship between the material properties of the colliding objects and the kinematic patterns of collisions.

In Experiment 1, we presented the participants with virtual collisions between two simulated spheres, which we call *A* and *B*. At the beginning of each animation, one sphere (*A*) appeared close to the left edge of the screen and the other sphere (*B*) appeared in the center. Then, *A* began to move horizontally from left to right towards *B,* uniformly and without rotation, until it made contact with it. At this point, *A* came to a stop and *B* started moving in the same direction as *A* had been moving, uniformly and without rotation. We manipulated the simulated materials of *A* and *B* according to a 3 Material *A* (polystyrene, wood, iron) × 3 Material *B* (polystyrene, wood, iron) factorial design. In each of the nine experimental conditions, we varied the velocity of *B* (the velocity of *A* was fixed at 15.5 cm s^{-1}) such that the v_A/v_B ratio could take on 21 possible values that ranged from 1/3 to 3. The participants were asked whether each simulated collision appeared "natural" or "unnatural". The results showed that people without specific instruction in physics intuitively understand that v_A/v_B increases with the mass of *A* and decreases with the mass of *B,* and that v_A/v_B varies more with m_A and m_B when $m_A<m_B$. The results also showed that people are somewhat insensitive to the violation of the energy conservation principles[1].

In Experiment 2, we focused on the participants' intuitive understanding of the relationship between the elasticity of the colliding objects and the kinematic patterns of collisions. The two colliding spheres had the same simulated material, and hence equal implied mass. Thus, we could vary their elasticity while keeping their relative mass fixed at zero ($m_A-m_B=0$). There were two types of simulated horizontal collisions, named "Michottean" (similar to those in Experiment 1) and "head-on" (*A* and *B* moved in opposite directions and collided at the center of the screen.) We created 24 experimental conditions, resulting from a 2 Collision Type (Michottean, head-on) × 2 Precollision Velocity (fast, slow) × 6 Simulated Colliding Object (super balls, table tennis balls, tennis balls, rubber balls, terracotta spheres, plasticine spheres) factorial design. The participants were asked to *adjust* the coefficient of restitution implied by each collision until the collision itself appeared to be perfectly "natural". The implicit coefficient of restitution in collisions that appeared "natural" consistently varied with the simulated materials of the colliding spheres. As in Experiment 1, the participants proved to be somewhat insensitive to the violation of the energy conservation principles[2].

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Does a rhythm context reduce the intermodal effect on duration discrimination?

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When someone is asked to discriminate the duration between two time intervals, the intervals could be marked by a continuous signal (filled) or by two successive brief signals (empty). If empty intervals are used, discrimination is much easier if an interval is marked by two signals delivered from the same sensory modality (intramodal) than by signals delivered from the different modalities (intermodal)[1,2].

It is also known that in a duration discrimination task, discrimination is improved when intervals to be discriminated are presented several times. Indeed, two views have long been contrasted regarding the processing of subsecond intervals: duration-based (single interval presentation) vs beat-based (multiple interval presentations) processing. What is reported here is the first of a series of experiments designed for testing if the negative impact of the intermodality on discrimination could be reduced in a context where a beat-based mechanism might be employed[3,4].

In this experiment, different standard (400 and 800 ms) and modality conditions are used: with sequences of auditory signals (standard intervals) ending with a last signal delivered in the visual (AV comparison interval) or auditory modality (AA comparison interval); and with sequences of visual signals (standard intervals) ending with a last signal delivered in the visual (VV comparison interval) or auditory modality (VA comparison interval).

In six 45-min sessions, participants complete a temporal bisection task. These sessions correspond to six experimental conditions: 3 number-of-stimulus conditions (3, 4, or 5; i. e. 2, 3 or 4 intervals presented) × 2 standard conditions. On each trial, after the presentation of 1, 2 or 3 standard durations, the last interval is the comparison interval. Each session contains four blocks of 144 trials, each blocks corresponding to one of four conditions, i. e., with the comparison (last) interval being AA, VV, AV, or VA. At the end of each sequence, the participant indicated whether the last interval was shorter or longer than the standard(s). The comparison intervals lasted 275 to 525 ms, or 550 to 1050 ms.

The results indicate that there is no improvement of the discrimination levels in the intermodal condition when the number of standards is increased. Indeed, even in the intramodal conditions performances were not improved with the multiple presentations of the standard, a finding consistent with some reports indicating that it is more important to increase the number of comparison intervals than the number of standards.[5] The results also indicate that the intermodal effect is much stronger (higher Weber fractions) at 400 than at 800 ms. As for perceived duration, AV intervals are perceived as longer than AA intervals, but only at 400 ms; and VV intervals are perceived as longer than VA intervals. These effects on perceived duration might depend on the time needed to detect auditory vs visual signals.[6]

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Reallocation of attention under test anxiety

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The study analyzed the nature of the redistribution of attention under the influence of test anxiety. The study investigated test anxiety as a special case of general anxiety. The fact that anxiety significantly affects the processes of attention has been repeatedly confirmed[2,4]. K. Goldstein believes that anxiety leads to a loss of attention and a loss of clearly perceived external object[3]. J. Easterbrook expresses a more specific assumption. He admits that test anxiety and related emotional activity narrows the attention field. This is why people experiencing this condition do not notice relevant information and fail to efficiently solve the problem[1]. We tried to clarify the following question: what happens to attention in a situation of test anxiety – whether it narrows or expands.

44 subjects (28 women and 16 men, average age 21) participated in the experiment. 22 subjects were included in experimental group, the others – in control group. The subjects performed first preliminary, then the main sequence of cognitive tasks on the computer. We used as a test an "attention span" task, in which the subjects were asked to reproduce the spatial location of dots as quickly as possible using the keyboard. Matrices 3×3 with stimuli (dots) were successively presented on the display, each one for 200 ms. The layout of the dots was randomly produced in each trial. The experimental session consisted of four series, each with 10 trials. The first series featured 3 dots, the second one 4 dots, the third one 5 dots, the forth one 6 dots. Latent response time, accuracy and dispersion of responses on the average at the matrix and for each cell of the matrix were recorded. The control group got neutral instruction which generated moderate operational tension. The other participants were told that their intellectual abilities would be tested; this instruction provoked emotional tension which was accentuated by negative feedback given between sessions.

The results of the experiment demonstrate the impact of test-anxiety on the speed of cognitive performance and the reorganization of attention in the process of reproducing spatial configurations. The "stressed subjects" spent more time for cognitive processing of stimuli which resulted in slower answers. The two groups of subjects differed radically in reaction times. This difference was 112.25 ms which can be defined as "cost of anxiety". There was no significant difference between the groups either in the percentage of correct responses or in the indicators of variability of responses. When the number of elements in the matrix was increased, the reaction time got higher as well. This pattern was evident for both the experimental and control groups. The differences between groups were significant for any number of stimuli. At the next stage of data processing we analyzed the spatial distribution of correct answers across the cells of the matrix. The general trend is that the number of correct answers decreases, following the diagonal from the upper left to the lower right corner. Comparing the results of the distribution of correct answers in the two groups, we can conclude that as test anxiety grows, there is an increase of attention to the left part of the matrix (to the zone of the beginning of reading) and a weakening of attention to the right part of the matrix. These data contradict both the ideas of K. Goldstein and assumptions of J. Easterbrook. It was also demonstrated that test anxiety causes spatial reallocation of attention resources.

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POSTERS

The G. Fechner's and S. Stevens's laws in the spherical neural network model of analyzers

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Spherical neural network models of local analyzers of various stimuli have three layers of formal neurons – receptors, predetectors and detectors[1]. Detectors are selectively tuned for different stimuli properties values by their synaptic coefficients. The physical values of some stimulus property are encoded by *directions* of a vector describing an output of a predetectors ensemble as well as by *ordinal number or place* of the most excited detector in "a detector screen". In this model the objective various values (φ_p, φ_q…) of a *one-dimensional* stimulus property φ (light intensity, line length etc.) are displayed on a circle where subjective values of this property are located. This model describes subjective differences $D(\varphi_p, \varphi_q)$ between stimuli with property values φ_p and φ_q by an arc length between these stimuli. As noted in the article [2], one of the two versions of derivation of Fechner's law assumes that subjective differences $D(\varphi_p, \varphi_q)$ between p and q stimuli with one-dimensional property φ are additive. This postulate is expressed by an equation 1: $D(\varphi_p, \varphi_q)=D(\varphi_p, \varphi_r)+D(\varphi_r, \varphi_q)$, provided $\varphi_o \le \varphi_p \le \varphi_r \le \varphi_q$, where φ_o is an absolute threshold. Fechner expressed another postulate of his conception by an equation 2: $D(\varphi_p, \varphi_q)=F(\varphi_q/\varphi_p)$[2]. It means that the subjective difference $D(\varphi_p, \varphi_q)$ between two stimuli with property φ is a function F which depends on a ratio φ_q and φ_p of physical magnitudes of these property. It also implies that $F(\varphi_q/\varphi_p)=F(\varphi_q/\varphi_r)+F(\varphi_t/\varphi_p)$ from the equations 1 and 2. By a change of variables ($\varphi_q=x\varphi_t$, $\varphi_p=\varphi_t/y$) this expression is transformed into the Cauchy functional equation: $F(xy)=F(y)+F(x)$. It is fulfilled when the function F is logarithmic and non-negative. Fechner has defined the function F by this way, then putted it in the equation 2 and received his law in the form: $D(\varphi_0, \varphi_q)=k\bullet log_n(\varphi_q/\varphi_0)$, where φ_0 is an absolute threshold for property φ.

The spherical model of a analyzer can describe such responses to stimuli which correspond to either Fechner's or Stevens's law under certain conditions. When stimulus having the value property φ_q affects receptors, then they are excited to a magnitude r_{iq} depending on value property and the state of the i-th receptor input. Magnitudes r_{iq} are coordinates of vector $\mathbf{A_q}$ which describes a receptors ensemble output. The vector $\mathbf{A_q}$ enters a synaptic input $\mathbf{C_j}$ of each j-th predetector and excites the predetectors output up to a value $f_{jq}=(\mathbf{C_j}\bullet\mathbf{A_q})$, which is equal to a scalar product of the vectors $\mathbf{C_j}$ and $\mathbf{A_q}$. The values f_{jq} are a vector $\mathbf{F_q}$ coordinates, and $\mathbf{F_q}$ describes the excitation of entire ensemble of predetectors. As it was shown in the work [3], the two predetectors are enough for the one-dimensional stimulus property φ evaluation. In this case $\mathbf{F_q}=f_{1q}\mathbf{n_1}+f_{2q}\mathbf{n_2}$. When the $\mathbf{F_q}$ is unit vector, then $\mathbf{F_q}=cos(\alpha_1(\varphi_q))\mathbf{n_1}+cos(\alpha_2(\varphi_q))\mathbf{n_2}$, where α_1 и α_2 are angles between vector $\mathbf{F_q}$ and orthogonal unit basic vectors $\mathbf{n_1}$ and $\mathbf{n_2}$ of the two predetectors. Vector $\mathbf{F_q}$ enters a synaptic input of each k detector which is described by also unit vector $\mathbf{P_k}$. Detectors are excited up to values $d_{kq}=(\mathbf{P_k}\bullet\mathbf{F_q})$. One of the detectors having $\mathbf{P_k}=\mathbf{F_q}$ is excited to the maximum degree ($d_{qq}=1$). When an observer apprehends the subjective value of the stimulus property φ_q, he/she determines an ordinal number q of the most excited detector or its place in the ensemble of detectors, using a neural network. Two different values φ_q and φ_p of this property give a maximum excitation d_{qq} and d_{pp} to different detectors q and p. The angle between the vector $\mathbf{F_q}$ and $\mathbf{F_p}$ or length of an arc between stimuli with property φ_q and φ_p encodes a subjective (sensed) difference[1,3].

The Fechner's law for a one-dimensional stimuli is fulfilled when functions $\alpha_j(\varphi)=k\bullet log_n\varphi+\varphi_{j0}$, where φ_{j0} is phases of vector $\mathbf{F_q}$ coordinates. The unit length of vector $||\mathbf{F_q}||=f_{1q}^2+f_{2q}^2=1$ and $\varphi_{10}=90^0+\varphi_{20}=0$ implies that $\mathbf{F_q}=cos(k\bullet log_n\varphi_q)\mathbf{n_1}+sin(k\bullet log_n\varphi_q)\mathbf{n_2}$, where $k\bullet log_n\varphi_q$ is an angle between the vector $\mathbf{F_q}$ and the first coordinate axis measured in radians. The subjective difference $D(p, q)$ between the stimuli with property φ_q и φ_p is measured by an arc length between stimuli p and q on the unit circle. This arc length is equal to angle (in radians) between vector $\mathbf{F_q}$ and $\mathbf{F_p}$. Consequently, $D(p, q)=\alpha_1(\varphi_q)-\alpha_1(\varphi_p)=k\bullet log_n\varphi_q-k\bullet log_n\varphi_p=k\bullet log(\varphi_q/\varphi_p)$. This is the Fechner's law. The Stevens's law: $\Psi(\varphi) = k\bullet\varphi^n$ for a one-dimensional stimuli is fulfilled if a function $\alpha_j(\varphi)=k\bullet\varphi^n+\varphi_{j0}$. In this case $\mathbf{F_q}=cos(k\bullet\varphi_q^{\,n})\mathbf{n_1}+sin(k\bullet\varphi_q^{\,n})\mathbf{n_2}$, where $k\bullet\varphi_q^{\,n}$ is an angle between the vector $\mathbf{F_q}$ and the first coordinate axis. The Cartesian coordinates of the vector $\mathbf{F_q}$ (i. e. $cos(k\bullet\varphi_q^{\,n})$ and $sin(k\bullet\varphi_q^{\,n})$) describe physiological excitation of predetectors caused by the stimulus with property φ_q. The value of subjective evaluation $\Psi(\varphi_q)$ of property φ_q is proportional to the length of the arc between stimulus q and absolute threshold stimulus with property φ_0 having a input vector $\mathbf{P_0}$. The constant k in Fechner's and Stevens's laws affects the analyzer's sensitivity to the property φ. This constant is depended on the density of detectors for various ranges of property φ, on a magnitudes of a lateral inhibition between detectors as well as on the unit of measure property φ.

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The study of ethnocultural attitudes using the method of multidimensional scaling

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Currently the problem of cultural differences and attitudes is becoming more significant due to the globalization of cultural space, as well as mass migrations and radical social transformations at national level[1]. Routine procedures including questionnaires, interviews, etc. have long been the most common methods of studying ethnic preferences[4]. Previous studies have proved the multidimensional scaling (MDS) method to be informative in investigating the subjective distances between the psychological domains[2,3]. Unfortunately the MDS method have not been adequately assessed to measure ethnic preferences. We used MDS to study underlying preferences between Russians and 16 ethnic groups including nationalities living in Russia and near and far abroad. We assumed that these preferences are manifest in the structure of the "ethnic space" revealed by the MDS procedure.

Method. Nineteen observers (15F, 4M, age range 17–30) with normal or corrected to normal vision were tested. Most of our participants (85%) considered themselves Russians. Stimuli were words denoting the names of 16 ethnic groups. The following words were selected and presented in pairs: Russians, Germans, French, Chinese, Italians, Spaniards, Azerbaijanis, Armenians, Tajiks, Ukrainians, Belarusians, British, Greeks, Lithuanians, Serbs, Gypsies. In each trial a pair of stimulus-words was presented on a white background. The exposure time was 2000 ms. Participants were asked to rate pairwise dissimilarity of ethnic groups on a scale from 1 to 9. 240 pairs of words were presented. Then participants were asked to fill in two questionnaires: the Bogardus social distance scale (8 questions) and the focused interview (11 questions). Full matrices were processed with PROXSCAL multidimensional scaling program.

Results. Analysis of the data allowed to distinguish two dimensions D1 and D2 in captured ethnic variations (Stress = 9.7%): D1 separated X – "Western culture type" from other stimuli, with X – "Eastern culture type" at the other extreme; D2 opposed Slavic ethnic groups to other nationalities. The structure of "ethnic space" was compared with the Bogardus scale of social distances to reveal the correlation between the estimated preferences obtained using different measurement procedures. The comparison revealed the differences in configuration of "ethnic space" and the social distances, which may be explained by differences in the level of generalization of the concepts "social distance" used in two mentioned procedures. Our data were also confirmed by the participants' responses to focus-interview questions.

Our data may be interpreted as explicit clustering of certain ethnic groups on the basis of "common traditions", "phenotypic attributes", "geographical proximity" and "common language". Moreover, these categories have a complex internal structure, so further research is required to study cultural differences and attitudes. The MSD method has been proven the most efficient for studies of ethnic preferences.

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Additional sensory cues are indicators of self-regulation process in loudness discrimination

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An observer's work in threshold area takes place under the conditions of sensory information deficit and high rate of stimulus presentation. Therefore the central contradiction in performance of threshold task is the conflict between the need to effectively differentiate the signals and the observer's available resources. This contradiction is resolved in the form of additional effort directed to compensate for the deficiency of the resource or on the contrary by moving away from the task performance and trying to reduce resource costs. The psychological analysis of the process of a sensory task solution leads us to understanding that this process includes various high-level mechanisms of mental regulation of the observer's activity.

The purpose of our research is to clarify the role of the mechanisms of personal self-control defining the observer's strategies used to solve the threshold task of loudness discrimination of two tonal signals. With decreasing stimulus difference and therefore increasing difficulty of loudness discrimination, observers change over to qualitatively different way of working with signals: they distinguish them using the peculiar additional sensory cues (acoustic or/and modal ones nonspecifically) that help to pick up on a signal[1]. These sensory cues were given the name "additional" due to their additional relation to the key parameter of sensory discrimination – loudness.

A psychophysical research of loudness discrimination of tonal signals (method 2AFC) has been carried out, N=106. The experiment included two tasks with the stimulus difference of 1 and 2 dB. Each task was divided into 4 blocks of 100 trials. Additional sensory cues and individual performance strategies were identified in self-reports by content analysis. The influence of self-regulation (questionnaires: HAKEMP-90, Style of self-regulation of behavior, Self-organization of behavior) on RT and sensory sensitivity index A' was investigated. The analysis of the change in RT while accomplishing the two sensory tasks (2 dB ($F(1,104)=10.931$; $p=0.001$) and 1 dB ($F(1,78)=6.691$; $p=0.011$) has shown the advantage of the Action Oriented observers (OA) and those with a high level of self-organization over the State Oriented observers (OS). In a more complex task (1 dB) the OS-observers showed a certain advantage in sensory sensitivity ($F(1,78)=7.341$; $p=0.008$). It is supposed that OA-observers used more economical strategy of information processing. They avoided long and comprehensive decision-making. OS-observers attracted more cognitive resources and used additional sensory cues more often. The qualitative analysis of individual ways of signal discrimination was carried out too. The evident relationship between loudness discrimination effectiveness and the characteristics of self-regulation processes mediating the sensory task solution was revealed. The way of applying the principle of Subject Activity Theory to traditional psychophysical research was elaborated in the framework of differential-psychological approach in psychophysics. The study also developed the idea that the variation of stimuli uncertainty leads to appropriate transformation of the functional organ or functional perceiving system (according to A. N. Leontiev, A. A. Ukhtomsky) relevant to sensory discrimination task demands.

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The influence of forward masking on object categorization. Basic and superordinate processing of visual information.

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It is well known that the recognition of a briefly flashed visual target is often weakened when it is preceded by a distractor (masking stimulus). The configuration similarity of the mask and the target improves the masking effect, but the influence of mask and stimulus semantic categories is still unclear.

The aim of present study was to investigate the dependence of relevant stimulus recognition on the type of experimental cognitive task. Participants were asked to categorize stimuli at the basic level (e. g., rabbit, fox, car, etc.) or the superordinate level (e. g., animate or inanimate). Twenty-seven healthy subjects participated in the experiments. In each experiment with basic level categorization the participants recognized four different stimuli which were all animals or man-made objects and pressed the respective button on the Serial Response Box (E-prime Psychology Software Tools Inc., USA). In superordinate level experiments subjects were asked to categorize pictures as animate or inanimate and press the respective button. The test images were preceded by forward masks. We used unfiltered and low frequency filtered images of four categories (face, house, animal and man-made object) as masks. The mask duration was 100 ms, the stimulus one was 85 ms. The noise backward mask (100 ms) was used to interrupt visual processing. The accuracy and reaction time were analyzed.

It was found that the performance depended on the kind of experimental condition, i. e. basic or superordinate level categorization. At the basic level categorization, performance was worse when mask and test images belonged to the same category. On the contrary, at the superordinate level categorization the masking effect was the strongest when mask and test images belonged to different categories. Faces and houses produced a weaker masking effect than animals and man-made objects. Importantly, low-frequency filtered masks evoked a lesser masking effect than unfiltered ones.

Our results are consistent with the hypothesis[1] that basic and superordinate levels of categorization are temporally and spatially separable in the brain. Faces and houses are specific categories of images which activate the distinct brain areas (occipital face area and fusiform face area for faces and parahippocampal place area for houses)[2], and therefore may have a lesser masking effect than animals and man-made objects. The weakened masking effect produced by low-frequency filtered mask highlights a more important role of the ventral pathway in forward masking mechanisms.

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Perception of quality of life and psychophysical characteristics

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We used an interdisciplinary approach to conduct a comprehensive study of the relationship between the perception of the quality of life of a person and his or her sensory perception (sensory task performance). What is the psychological essence of perception as a whole? How to get a three-dimensional picture of perception process? The solution to such problems is to use the idea of systematic nature and systemic determination of one's psyche and behavior. In order to provide a more complete and holistic description of perception the authors propose to include psychophysical characteristics in the general study of the subjective quality of life (SQL) and to determine the role of these characteristics in SQL structure. SQL is defined as a set of life values that characterize human creative activity and development, satisfaction with life, social relationships and environment[1,2].

We investigate two hypotheses. 1. There is a relationship between SQL parameters and sensory task performance parameters. 2. There are groups of people with different levels of psychophysical characteristics and parameters of quality of life.

21 subjects took parting the study (Germans, men and women, age range 20–40). The data was obtained by E. V. Golovina in a research carried out in Germany at the University of Munich.

Methods:

1. The method of the subjective quality of life (SQL) estimation used by T. N. Savchenko and G. M. Golovina is designed to estimate the values most significant to the respondents (the SQL questionnaire has been translated and adapted for the German sample).
2. Visual durations discrimination characteristics were evaluated: a difference between a standard duration (600 ms) and a comparable one (600 ms – Δt) giving 70–80% correct responses, a proportion of correct responses, an average confidence category used, realism of confidence index: Bias – a difference between the average confidence category and the proportion of correct responses (I. G. Skotnikova and V. A. Sadov method).

Correlation and cluster analysis were provided.

Results obtained: psychophysical performance characteristics were linked to quality of life parameters related to psychophysiological peculiarities in some fields (sports, health, recreation, and others.). Thus, people confident in their sensory impressions also have good health, confidence in their future, they are satisfied with their profession and work. Those who adequately assess the correctness of sensory tasks performance, enjoy personal freedom, do sports, take good rest and rate their life satisfaction highly.

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Temperamental characteristics of confidence in the task of musical fragments comparison

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The experimental study analyzed the perceived differences in digital sounds recorded in WAVE (CD quality) and MP3 (64 kbps) formats. 9 musical fragments were recorded, each in two formats, and presented to listeners in a paired comparison procedure[1]. Participants were to choose a preferred sound in each pair, to evaluate the difference between two sound formats using the 8-point scale and to compare them verbally. The verbalizations were analyzed by means of the systematic method elaborated for situations of comparison[2]. The verbal index of confidence was considered to be the difference between the number of verbal units describing the state of confidence (e.g. "exactly", "sure", "of course") and that of doubt (e. g. "it seems to me", "I doubt") [3]. The number of requests to repeat the musical fragments and dispersion of the auditor's evaluations of the difference between the sounds were also taken into account. Responders' temperamental characteristics (tension, plasticity, speed and emotionality) in three spheres (psychomotor, intellectual and communicative one) were tested by V. M. Rusalov's questionnaire. Self-confidence was measured by V. G. Romek's questionnaire.

Results. Confidence in distinguishing musical fragments correlated negatively with plasticity in three spheres – psychomotor, intellectual and communicative one, and correlated positively with communicative tension. Requests for repeats correlated positively with total emotionality and communicative activity. The range of evaluations of the difference between sounds correlated positively with self-confidence and negatively – with intellectual tension and plasticity and communicative activity.

Discussion. Plasticity causes doubt and prevents taking a final decision. Communicative tension is the ability to be constantly prepared for social contacts. A person who wants and knows how to make contact is more confident in assessing the differences between musical fragments. More emotional and communicatively active listeners are characterized by more requests for repeats. Highly emotional people try to be as precise as possible in identifying the differences between musical passages, and for this they need a constant communication with the external environment (experimenter). It seems that frequent requests for repeats made by communicatively active persons are more an attempt to communicate with the experimenter. The dispersion of evaluations of difference is higher in more self-confident people (full range from "1" to "8"). Confidence is correlated with such cognitive styles as "field independence" and the "ability to train"[3]. Focusing on oneself, on the one hand, and the ability to analyze a changing situation, on the other, also facilitate assigning higher values of difference to musical fragments. Besides, confident people are positive about themselves and more easily use the full range of the 8-point scale. A smaller range of estimates ("1–3") is used by intellectually tensioned people with high plasticity and communicative tension. Perhaps a person more tuned to the analysis of his feelings rather than to communication, identifies more differences in sounds presented in pairs.

Thus, the study shows a new way of indirect evaluation of confidence (on the basis of the analysis of verbalizations) in psychophysical task of musical fragments comparison, and reveals correlations of confidence level with temperamental characteristics.

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Evidence based outcomes utilizing a psychophysical assessment tool for identifying neurodevelopmental delays including autism

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Psychophysical Science is based upon the assumption that a quantitative relationship exists between environmental stimuli and sensory perception. The fields of Optometry and Audiology utilize inventions derived from psychophysical principles for assessing the quality of vision and hearing function. Due to advances in scientific research, a similar psychophysical assessment tool can be developed and utilized to assess age appropriate human performance development of the whole child's interaction with their environment. An effective assessment tool would identify children at risk for neurodevelopmental delays including autism during the brain's early critical wiring period when interventions would be most effective.

Children with neurodevelopmental delays including autism often exhibit a breakdown in the human performance system between sensory inputs to behavior outputs. Sensory systems require gravity to function optimally and have critical periods for development. Advances in therapeutic science have uncovered the critical nature of sensory function and integration to human developmental milestones. Early identification and intervention is vital to the brain's optimal growth.

The psychophysical assessment tool focuses on measuring key sensory, cognitive and behavior data as specifically related to the environmental interface. Applying the assessment tool extends traditional Fechnerian principles to include the influence of the gravity vector on the development of biologic systems. The assessment tool offers a new way to measure and collect data. This presentation will review data collected based upon these principles. We will compare the viability of present assessments with the psychophysical assessment tool. Data will be further analyzed to determine if proven outcomes assist protocols for identification and treatment of children at risk for neurodevelopmental delays including autism. Creating new assessment tools, interventions and programs can be achieved by applying a new perspective to core Psychophysical principles.

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Evaluation of self-motion illusion strength using virtual reality

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Virtual reality technology is a system of visualization tools, which includes special virtual environment devices (CAVE-systems, systems of augmented reality, HMD helmets, spherical displays), as well as simpler devices, such as widescreen projection 3D-displays, 3D-theatres and virtual reality goggles[1]. In the last decade virtual reality technologies has become a common method of various psychological studies. Virtual reality in particular is widely applied in self-motion illusion (vection) investigations. The experience of vection is subjectively manifested in the perception of one's own body movements, when an observer is looking at a large moving visual field[2]. The present study is aimed at developing a method of quantitative evaluation of self-motion illusion strength using virtual reality technology combined with eye tracking. The vection illusion was evoked by virtual environment rotation in the CAVE (Cave Automatic Virtual Environment) virtual reality system. The display initiating the vection illusion consisted of 256 blue circles moving around the centre point in long elliptical 3D trajectories with a changing angle of slope. The whole scene subtended 60°×60°, 90°×90° and 180°×180° of visual angle for the first, second and third conditions of viewing respectively. The study involved 15 figure skaters aged from 16 to 18 (experimental group) and 15 students of the Lomonosov Moscow State University aged 17–18 (control group), who had very little experience as skaters or had no such experience at all. All subjects have normal or corrected vision and have no pathology of the vestibular function.

The quantitative evaluation of vection strength was based on eye movement characteristics registered while perceiving the vection illusion. Simulator Sickness Questionnaire[3] was used as a subjective measure of vection strength and negative symptoms (nausea, vomiting) level. The result of the experiment allowed us to estimate blink and fixation frequency as well as amplitudes of saccadic eye movements during the vection illusion. Besides, the total point of the SSQ questionnaire was calculated. ANOVA revealed an insignificant impact of "viewing angle" factor ($F=4{,}377$, $p=0{,}01$, $df=16$) for the first and the second series (viewing angle 45° and 90° respectively) of interaction between within-subjects and between-subjects factors ($F=2{,}718$, $p=0{,}01$, $df=16$). Eye movement characteristics of the experimental and control groups in these series were very similar. However, in the third series (viewing angle 180°) the results showed significant differences in number of fixations ($t=2{,}208$, $df=29$, $p<0.05$) and number of blinks ($t=2{,}066$, $df=29$, $p<0{,}05$). Total scores from SSQ were consistent with the eye movements data: the control group revealed significantly higher level of subjective discomfort while experiencing the vection. Thus the ability of virtual reality to evoke vection and of the eye tracking to evaluate vection strength was demonstrated.

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Perceptual adaptation as a way to explore the structure of facial expressions space

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There exist two main theoretical approaches to the study of facial emotional expressions perception. According to the dimensional approach, all emotions and their displays may be described by a small number of bipolar characteristics, such as positive/negative valence and high/low arousal[1]. An alternative view assumes a number of basic emotional categories with qualitatively different physiological, subjective and expressional patterns[2]. Despite a large amount of research it is still unclear, which approach provides a better description of the structure of perceived facial expressions. Perceptual adaptation studies seem to be efficient in solving this issue. Adaptation implies that the observer's sensitivity to a particular facial expression is reduced substantially after a prolonged observation of this expression, and the perception is biased away from the adaptor.

The aim of our study was to explore the perception of facial expressions after adapting to different basic emotions. The dimensional approach predicts that adaptation to, say, "Happy" expression would cause not only selective sensitivity reduction to the same emotion, but also enhanced sensitivity to the opponent (i. e., "Sad") emotion. On the other hand, if basic emotions comprise independent categories, one would expect only lower sensitivity to an emotion adapted, and no change in the perception of other expressions.

In our psychophysical study we compared facial expressions perception after adaptation and without it. First, participants (N=26) categorized images of female faces presented for 50 ms as one of the six basic emotions or as a neutral face. The stimuli showed 6 emotions of 8 intensity levels (5 repetitions per image, 240 trials in total). Individual psychometric curves were fitted and the intensity of each emotion recognized with 50% accuracy. The images of the six emotions were further presented in the identification task after 6-second adaptation to each of the 6 dynamic expressions (and the neutral face) of the same actress.

We found that the perception of several expressions indeed changes after adaptation to the emotional face, compared to the neutral one. In particular, adapting to a dynamic happy face reduces the sensitivity to happiness ($\chi^2_{(1)}$=45.2; p<0.001) but enhances the perception of sadness ($\chi^2_{(1)}$=23.1; p<0.001). Adaptation to disgust declines the identification of anger ($\chi^2_{(1)}$=11.5; p = 0.005) and tends to decline the identification of happiness ($\chi^2_{(1)}$=7.0; p=0.05). Surprise is recognized worse after an adaptation to surprise ($\chi^2_{(1)}$=49.0; p<0.001), fear ($\chi^2_{(1)}$=105.6; p<0.001) and sadness ($\chi^2_{(1)}$=21.1; p<0.001).

The results obtained do not allow to prefer one theoretical approach over the other. In accordance with previous studies[3], the asymmetrical interactions between emotions in perceptual space have been observed. We suggest that both modes of perception, categorical and dimensional, co-exist as different stages of perceptual categorization. Probably, the opponent coding is used at the early stage of perception to discriminate emotions by their valence (e.g., "Happy" from "Sad"), whereas further discrimination of other emotional modalities requires a finer comparison between features of distinct categories.

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Human brain networks for visual spatial orientations processing

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The orientation sensitivity is very important for human behavior, but its brain mechanism is unknown. In the current study we analyzed the involvement of visual and nonvisual brain areas in the orientation processing.

41 subjects (20 males and 21 females) were asked to identify line orientations in square-wave grating patches of four orientations (horizontal, vertical, inclined at the angle of 45° and 135° from vertical). The 128-channel recording of ERPs was performed. Dipole sources were modeled using the weighted Minimum Norm Estimates (wMNE) method, ICBM152 anatomy and OpenMEG BEM head model. Dipole sources were analyzed for the time periods corresponding to the wave peaks P100 (80–110 ms), N150 (140–160 ms), P300 (300–350 ms) and Late Negativity (LN) (400–600 ms). The obtained data indicate that there are two different stages of orientation processing: sensory (P100 and N150) and cognitive (P300 and N400). The Bivariate Granger causality analysis for the time periods corresponding to the sensory (0–200 ms) and cognitive (350–550 ms) stages of the orientation processing was conducted. A multivariate autoregressive (MVAR) model was constructed from the summary time series of the 68 ROIs. Model order 10 was chosen based on the Akaike information criterion (AIC).

Our results reveal the temporal evolution of brain activity topography and network connections. Sensory stage (before 200 ms) was characterized by greater activity at low-level visual areas and the inverted oblique effect that was manifested as higher ERP amplitude and broader activation area for the oblique orientations than for the cardinal ones. Cognitive stage (200–500 ms) was characterized by greater activity at frontal and temporal areas and classic oblique effect – higher ERP amplitude and broader activation area for the basic orientations. The pattern of network connections was found to be different for sensory and cognitive stages. At the sensory stage there were numerous connections within the visual (occipital, temporal and parietal) areas and between visual and frontal areas, while at the cognitive stage the number of connections within visual areas reduced. However, there still were numerous connections between visual and frontal regions.

To sum up, basic and oblique orientations might evoke selective answers not only in visual cortex. The involvement of the frontal areas proposes the role of orientation sensitivity in the goal-directed behavior.

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The psychophysical analysis of the threshold of visual perception of two-dimensional figures during late adolescence and youth

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The estimation of visual stimuli depends on the level of maturation of sensory systems and is directly connected with such individual characteristics as gender and age[1]. Individual personal experience should also be taken into account. The classical approach in psychophysics and psychophysiology indicates the maturing of visual sensory system at preschool and younger school age[2]. At the same time, the perception of visual stimuli during late adolescence and youth still needs additional research.

The classical psychophysical method of threshold measurement – the method of simultaneous constant stimuli – is used in this research. The threshold of the visual perception of a two-dimensional figure – a circle – are studied on the samples of schoolers (14–18 years, 58 people), psychology students (17–22 years, 43 people) and architecture students (18–20 years, 27 people). The values of the thresholds are received as a result of the analysis and subsequent processing of psychometric curves of each examinee.

The study shows that on the samples of schoolers and any type of students there is a significant ($F > Fcr$, $p<0.05$) decrease in the thresholds of visual perception of the size of the circle in subjects from 14 to 17 years old. There are two main points of transition – within the sample of schoolers between groups of 14 and 16 year old, and between 14–16-year old schoolers and students of 17 and elder. The maximum contribution to the age variability is made by the female part of the subjects. The reliable ($U<Ucr$, $p<0.05$) intersexual differences of perception threshold are observed in the groups of schoolers from 14 to 16 year-olds and in the group of architecture students. It can be observed that in the groups of schoolers visual perception threshold is higher among the male part of the subjects, while in the group of architecture students visual perception threshold is higher among the female part of the subjects. The comparison of the groups of architecture and psychology students of the same age (18–20 years) shows that visual perception threshold is significantly ($U<Ucr$, $p<0.05$) higher among both male and female subjects studying architecture.

Thus, the perception of visual stimuli during late adolescence and youth has its own characteristics. According to the research, gender and age make their contribution to the value of visual perception threshold as well as individual experience of the examinees, which demands additional researches.

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The test of homing hypotheses as psychophysical task

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The homing or fish return to his own water for spawning is a characteristic quality of many representatives from sturgeon and salmon family. At present time two hypotheses of fish homing at "river stage" are exist. North-American hypothesis proposed that juvenile fish imprint the key odor of their home-stream (free amino acids, FAA) before migrating to the sea and adult fish use this key odor at spawning migration as cue for homing to their home-stream. Scandinavian hypothesis proposed the inborn memory of fish to key odor of his own (parental) population (bile components of feces, BCF), by means of which juvenile fish at downstream migration marked the way for adult fish. In both cases the concentration of key odors in mouth of river is very low and have sloping gradient from home-stream to mouth of river. In next streams the difference of key odors in quality is insignificant. Therefore, for successful homing fish are necessary high differential sensitivity to key odor and the ability to discrimination of similarity key odor. Thus, the test of homing hypotheses is the psychophysical task.

The ability of juvenile fish to remembering of the distinct environmental odors by exposition (passive learning) revealed in salmon[1] and sturgeon (own data). The inborn memory of sockeye salmon fry to key odor of his own population revealed in preference experiments in a two-choice Y-through[2] and confirmed by field experiments of our laboratory (A. Zvezdin). The comparison of concentration FAA and BCF dissolved in home-stream water with FAA and BCF thresholds detection, recorded at sensory level of Pacific salmon in the background of home – stream water, indicated practically the same sensitivity to this odors[3]. Consequently, both FAA and BCF are possible key odors.

Our investigation of the ability to discrimination of similarity odors and differential sensitivity of untrained juvenile sturgeon was carry out with help of original technique which combines psychophysical constant stimulus method and ethological "habituation–discrimination" method.

As a result of a test were established that juvenile sturgeon a) capable of distinguishing a structural and optical isomers of FAA; b) have a low difference thresholds of detection and recognition of FAA: until 0.005% in the presence of natural background and until 0.01% in the presence of artificial backgrounds; c) have a low difference thresholds of recognition of natural multicomponent odors: until 0.03% by FAA pool in the presence of natural background and until 0.1% in the presence of artificial backgrounds, at that differential sensitivity of sturgeon to fecal odor of conspecific (BCF pool) and to fodder odor (FAA pool) practically identical.

Thus, our and literature data indicate that for sturgeon and salmon are served both homing hypotheses.

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Who or what is more sensitive to odour – the fish itself or the sections of its chemosensory system?

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With the appearance of the electrophysiological method, the chemical sensitivity (ChS) of fish was mainly studied on the various levels of the chemosensory systems (ChsS). In this regard, a number of prominent results were achieved, including a large body of data from the Russian scientists. However, to what extent the sensitivity of the ChsS reflects the chemical sensitivity of the fish itself, is still an open question. In order to answer this question, a comparison of thresholds of detection and recognition for individual amino acids (AA) in five well-studied species of fish – the common carp, the bank cod, the rainbow trout, the Russian sturgeon and the common catfish – was carried out on the diverse levels of ChsS (literature data[1,2]) and on the level of the subject (our own experimental and literature data[1,2]).

We carried out our researches of untrained groups of carp, trout, cod and sturgeon with the help of a unique technique which combines the psychophysical "constant stimulus" method and the ethological "habituation–discrimination" method. In our experiments, the changes in the motor performance of fish were measured. In the experiments of other researches the thresholds of AA discrimination in untrained sturgeon were determined on the basis of the eating behaviour response[2]. When testing pre-trained catfish items, the thresholds of AA detection were determined on the nonspecific behavioral response, and the thresholds of AA recognition – on the eating behaviour response[2].

The comparison of these data revealed that:

- the ChS of the common carp on the behavioral level is higher than on the level of ChsS;
- the ChS of the bank cod on the behavioral level is higher than on the level of ChsS;
- the ChS of the rainbow trout on the behavioral level is not lower than on the level of ChsS;
- the ChS of the Russian sturgeon on the behavioral level by recording the motor performance of the fish is higher than on the level of ChsS, but by recording the eating behaviour response of the fish is lower than on the level of ChsS;
- the ChS of the common catfish on the behavioral level is lower than on the level of ChsS.

It is known that while being trained, the fish memorize not only the quality of the test substance but also its concentration. And this influences the results of the catfish test. Moreover, it is obvious that for the measurement of the threshold of recognition, "motor performance" is a more suitable indicator than "eating behaviour response". Therefore, one can consider that the chemical sensitivity of fish as subjects is higher than on the sensory level.

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The psychophysics of aging. In emotional speech, older adults attend to semantic, while younger adults to the prosody

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The ability to correctly perceive and identify emotions in speech is at the core of human communication. To identify an emotion, one should be able to process and identify the semantics (lexical meaning) and the prosody (tone of speech) of the utterance, and integrate them. Deciphering this complex interplay of prosody and semantics may become even more challenging in older age. Age-related changes in auditory-sensory factors and cognitive processing may hinder correct identification of emotions in spoken language. There is abundant evidence in the literature that older adults have difficulties in identifying emotions in speech. However, there is missing and inconsistent evidence about the different processes underlying this effect. The current study examines age-related differences in the perception of emotions in speech. Specifically, focusing on the relative roles prosody and semantics play for older vs. younger adults.

The study used a novel tool, Test for Rating of Emotions in Speech (T-RES)[1,2], designed to assess the complex interaction of prosody and semantics in spoken emotions. Twenty older (age: 65–75) and 20 younger (age: 20–30) listeners were presented with 25 spoken sentences. The emotional valence of prosody and semantics appear in different combinations from trial to trial, with four separate discreet emotions (anger, fear, happy and sad) and a neutral (baseline) emotion. In the current study, listeners were asked to rate the sentence as a whole (integrating both speech dimensions), as if they are talking on the phone. Each sentence was presented four times, rated on four emotional scales (anger, fear, happy and sad) in four separate blocks. Spoken sentences were presented 40 dB above individual auditory thresholds (PTA), in a sound attenuated booth.

Results reveal significant age-related differences in the integration of speech dimensions. For younger adults, emotional ratings appear to be impacted mainly by the (emotional content of the) prosodic dimension, with only a small contribution of the semantics. Whereas older adults, appear to apply different weights, where both dimensions contribute to the emotional ratings. Consider the semantically happy sentence "I won the Lottery" spoken with angry prosody. Younger adults rated it as expressing mostly anger with only a modicum of happiness, whereas older adults as expressing both anger and happiness to a similar extent. Finally, the study suggests a novel outlook on age-related differences in daily performance – focusing on the different weights older and younger adults assign to the different dimensions, rather than attributing age-related differences in performance to age-related differences in cognitive abilities (echoing information degradation hypothesis[3]).

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The characteristics of memory in the ecological and time context

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The purpose of this work is the experimental study of psychophysical characteristics of short-term and long-term memory in tasks of distinction of duration of light stimuli in laboratory and natural conditions.

Research tasks: 1. To compare the sizes of psychophysical indicators in tasks of distinction of duration (presentation of the standard in each pair and once) in usual and rolling conditions. 2. To define the influence of on the psychophysical indicators in distinction tasks.

The research consisted of four experimental series: two series – in usual conditions (background), two series – in rolling conditions. The experiments were made in the internal part of the floating stand (yacht) in usual and rolling conditions (frequency of 0,5–0,7 Hz, angular speed to 60 hails/sec.). In the first half of the series the classical method of constants was used, and in the other half – the method of individual stimuli. As a standard, a square duration was used (2 seconds). In the method of constants, the test consisted of a consecutive presentation of the standard and the compared stimuli with a 1-second interval. The task of the subjects consisted in estimating the duration of the compared stimulus in relation to standard duration, pressing the keys corresponding to the answers "less", "equal" and "more". In the method of individual stimuli, the standard was once shown to a subject for 2 seconds in order for him to memorize its duration, and then the compared stimuli followed. The task of a subject consisted in comparing the duration of the shown stimuli to the remembered standard duration, pressing the corresponding keys.

The results of research showed the existence of underestimation of duration of a standard on average on group in all the four series and almost in all subjects ($p<0,05$). The comparative analysis of the results received in the series with presentation of a standard in each couple and once did not reveal any significant distinction between all the indicators on average in the group. The dispersive analysis did not reveal any influence of the rolling on PSE and DL values. The analysis of personal data gathered under the conditions of rolling showed PSE and DL value increase in some subjects, decrease in other, and no change at all with the rest. The fluctuation of the usual answers "more", "equal" and "less" under the conditions of rolling was no different compared the one on average in the group and in the majority of the subjects. Thus, the received results demonstrate that such factors as features of presentation of a standard (once or in each pair) and the influence of rolling did not have any impact on the value of psychophysical indicators at the distinction of duration of light stimuli.

The results correspond with the data obtained on other stimulus material which also did not show any effect of distinction against a standard to short-term and long-term memory. On the other hand, the consistent patterns of dynamics of psychophysical characteristics of short-term and long-term memory determined in vitro, are confirmed under natural conditions, with inclusion of an ecological factor – the influence of rolling – that testifies to the fundamental nature of the received results[1].

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The connection between personal traits and standard features in memory

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In our previous research devoted to the dynamics of physical and semantic characteristics of a memory standard two aspects were considered: the dynamics of characteristics of duration reproduction of a standard and the dynamics of the structure of the semantic description during its storage in long-term memory (from 20 minutes to 28 days)[1]. The greatest changes of duration of a standard happened at the very beginning of storage from 20 minutes to 7 days. It can be noticed that the basis of the variability of duration reproduction is made by individual distinctions.

The purpose of this work is to identify the connection between personal traits (an extraversion–introversion, a neurotism, state anxiety and trait anxiety) and the characteristics of the semantic description and reproduction of duration of a standard stimulus (stability and accuracy) during its storage in long-term memory.

The procedure and methods of research. As a standard the singing of birds in the wood (2449 ms) was chosen. In our research the following methods were used: the semantic differential (SD) for the description of a sound fragment, a method of duration reproduction, the personal EPI test of G. Ayzenk (V. M. Rusalov's adaptation), the test of state anxiety and trait anxiety of Ch. D. Spilberger, Yu. L. Khanin. The research was conducted individually and consisted of five series (delay time from 20 minutes to 28 days). The standard was shown once for storing in the first series. In 20 minutes the subject reproduced the standard duration pressing a key. In each series the subject estimated the characteristics of the sound fragment by SD parameters, filled in the test of state anxiety and reproduced the duration of the sound fragment.

The results of the research showed that with the increase of the duration of a subjective standard it is estimated as more indistinct, sadder, deafer, smoother and less sharp, bright, sharp and complete. With the increase of anxiety the accuracy of reproduction of duration of a standard stimulus decreases. The state anxiety of the subjects' changes during the standard storage in long-term memory. They become less anxious on the 14th day of storage, with the subsequent increase of the state anxiety till the 28th day storages. Almost all the signs of the semantic description of a sound fragment are connected with state anxiety. The correlation analysis showed that with the escalation of state anxiety the sound fragment is estimated as a lower, shorter, more irritating, steeper, heavier, more tiresome, more rigid, more mournful, sadder, and less-bright, often met, animated, comfortable, attracting, strong, pleasant, natural, familiar, ringing, relaxing, joyful, accurate, happy, loud, live one. The correlation analysis also showed that with the increase of trait anxiety and neurotism, the sound fragment is estimated as more abrupt. And with the increase of extraversion the sound fragment is estimated as softer, more favourable, thinner and less tiresome one. Thus, personal traits are connected with the physical and semantic characteristics of a memory standard.

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The role of semantics in the duration of the reproduction of sound fragments

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In our work the main attention is paid to subject, semantic content of sensory and perceptual information perceived by a person and its influence on the perception of a time interval. Time perception is considered as an integral phenomenon, and the assessment of a sound process duration is not displayed as a sequence of discrete events.

The hypothesis of the interdependence of the qualitative content of natural and artificially created sound signals and the perception of their duration underwent an experimental check. The following tasks were set: to design a method for definition of the latent variables determining the description of natural, reverse and tonal sound fragments; to reveal the relationship of the semantic description of the natural and artificially created fragments with the performance indicators of reproduction duration; to investigate the features of the duration of natural, reverse and tonal sound reproduction.

The technique for detection of semantic description of natural, reverse and tonal sound fragments was designed as a semantic differential[1]. As stimuli, material natural sound fragments were used: the sound of a falling drop – 203 ms, the sound of an axe striking a tree – 505 ms, a bark of a dog – 555 ms, a call of the cuckoo – 612 ms, a meow of a cat – 995 ms, a horse hoofbeat – 1010 ms, a clock chime – 1082 ms, singing of birds in the wood – 2449 ms, a walrus scream – 3039 ms, and their reverse soundings (playing of a sound fragment in the opposite direction). One of the above – mentioned sounds was shown to each subject and each had to estimate its characteristics on the SD points. All in all, the subjects listened to 18 sound fragments (9 – natural, 9 – reverse). Further the same sounds were played to the subject at random. He had to reproduce the sounding duration by pressing the button.

As a result of the factorial analysis of the SD forms, 6 factors identical both for the description of natural and reverse sounds were singularized. For the verification of the received results double cross-validation was carried out, with the use of tonal signals and a selection of a different group of subjects. The factorial analysis of the given SD of natural, reverse, tonal sounds revealed 6 invariant factors of its description. 6 scales were created: undifferentiated emotional assessment of a sound (coefficient alpha=0,94), naturalness of a sound (coefficient alpha=0,92), popularity of a sound (coefficient alpha=0,92), height (coefficient alpha=0,78), sharpness of a sound (coefficient alpha=0,85), sound intensity (coefficient alpha=0,76).

Conclusions: latent variables defining descriptions of sounds were revealed. The latent variables are identical for natural, reverse and tonal soundings. Scales for the description of the sound fragments were designed and their psychometric characteristics (reliability coherence, cross validity) were defined. The sounds estimated as natural, well-known and strong were reproduced with the least mistakes. The duration of natural sounds was reproduced with a less mistakes than reverse and tonal sounds of similar duration.

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Electroencephalographic Evidences of Cervical Pain Causes

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The experience of pain serves specific primary purposes, which are critical for survival. Pain is a foremost a warning signal, which protects the organism from harm or at least minimizes injury. Pain receptors, or nociceptors, are widespread in the body. An extensive network of nociceptors can signal about damage from any place on the skin, or in deeper tissues including bones, muscles and viscera[1,2]. Insufficient study of the problem of pain is the reason for different approaches to pathogenesis and treatment[3,4]**.** Cervical pain is monosymptomatic and the spectrum of underlying etiologies is broad. Special support is provided to determine the nature of cervical pain objectively.

Group of 168 patients (men – 71, women 97, age 47±15) with chronic neck pain complains was enrolled. All subjects had undergone the MRI testing procedure. This technology revealed 70 subjects with spine herniated discs and narrow cervical spinal channel. It is a useful experimental design that can yield objective data about the nature of pain.

At the same time electroencephalograms were recorded. Statistics was applied to 300 samples of each patient to obtain group predictors. Interrelation of 82% was obtained between oscillations in right central and left occipital areas. Also 15% interrelation was obtained between oscillations in left central and right occipital areas. The other 3% reflect the similarity in main wave phases between right central and left occipital areas. In equations tn/fn+fp/tp=d/c+b/a=96/1+1/70 sensitivity, specifity, positive predictive value and negative predictive value were around 98%.

All neurophysiologic data obtained are involved in a person's cognitive space and are recognized in literature as Berger's and Livanov's constants.

Electroencephalographic measures used allow practitioners to understand the structure of health better in a way that has never been possible before. These evaluations are easy to administer because they can be downloaded from the internet and most of them can be performed without help of a professional.

Medical care authorities and insurance companies are the main customers of research on pain criteria. On the other hand these diagnostic methods assess the type, quantity, intensity, and quality of an individual's pain to determine whether they need surgery, a sick leave from work, or an ergonomic evaluation.

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Confidence in performance of sensory and perceptual tasks varying in difficulty (visual durations and facial emotional expressions discrimination)

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Introduction. A "Hard–Easy Effect" (HEE: underconfidence in easy sensory and cognitive tasks while overconfidence in hard ones) was described in Canadian, American and Australian persons in distinction of Swedish ones demonstrated strong underconfidence both in the easy and difficult tasks (see[1] for the review).

We examined, whether the HEE appeared in Russian participants who discriminated between simple sensory stimuli (short durations of light flashes) as well as of more complicated, ecologically significant perceptual stimuli (photos of a man's face expressed different emotions).

Methods. 300 pairs of visual durations and 300 pairs of faces were presented to each of 7 participants in an easy and in a difficult discrimination tasks (i. e. 4 experimental sessions were conducted). 2 responses were given in the each trial: 1) whether the 2 stimuli in a pair were same or different; 2) whether an observer was confident or unconfident in his/her 1st response correctness. The following indices were calculated: a proportion of correct responses, an average confidence category used (in percent), index of realism of confidence: Bias – a difference between the average confidence category and the proportion of correct responses.

Results obtained. In the easy task individual percent correct values obtained were 85–90% while in the difficult task – 55–60%. Confidence indices were statistically similar within each task for the both kinds of visual stimuli presented. But these indices were significantly lesser as compared to percent correct in the easy task while greater in the hard task. I. e. typical HEE was found for the both kinds of stimuli. Significantly positive correlations were revealed between individual confidence indices and indices of self confidence, obtained according Romek's questionnaire[2].

The main findings of the study. Thus, Russian subjects manifested the HEE like as Canadian, American and Australian persons in distinction of Swedish ones. This effect manifestation was statistically similar for the simple sensory stimuli (visual durations) and for more complicated, ecologically significant perceptual stimuli (facial expressions). And the confidence itself did not depend on the kind of visual stimuli used. Results obtained allow to suggest that within a certain difficulty level of a sensory and perceptive tasks performed, confidence in correctness of judgments given is rather stable individual feature, depending on personal traits mostly but not on a kind of objects perceived.

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Under-threshold discrimination in visual tasks

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Our research focuses on the investigation of decision making in near-treshold and under-threshold areas. Numerous studies in cognitive psychology indicate that unconscious perception is possible[1]. So we can conclude that absence of signal perception report (in other words, non-awareness of signal) does not always mean that the signal hasn't been received and processed.

We suppose that an observer can unconsciously discriminate seemingly equal stimuli in visual tasks. We have conducted two psychophysical experiments to check this hypothesis (the research was supported by SPbU, project № 8.38.287.2014). We have also developed a data analysis procedure never used before in psychophysical studies.

133 people participated in the experiments. The method of constant stimuli was used: the observers had to compare the length of pairs of horizontal lines (110 pairs of lines during the experiment, apart from training set). The stimuli were individually adjusted for each participant using the method of average error, so that in some pairs the stimuli were clearly different and in other pairs the difference was below discrimination threshold.

In the first experiment, there were three possible answers (less, equal, more). The position of standard line (left or right line in the pair) changed randomly. 73 people participated, 8030 measurements were made.

The procedure of the second experiment was identical to the first, except for the instruction (there were two possible answers: less or more) and the position of standard line, which was constant throughout experiment. 60 people participated, 6600 measurements were made.

The experiment proved our hypothesis and showed the aftereffects of observer's answers both below and above threshold. The participants tended to repeat their previous answers (right or wrong) although reported that almost all pairs of lines seemed equal. In both experiments, the aftereffects appeared at the 0.1% level of significance (Fisher's exact test). These effects show that there was an unconscious discrimination between subjectively equal stimuli. Otherwise the observer would not be able to repeat his previous response. After all, it is necessary not just to remember their answers, but also to distinguish one pair of lines from the other (note that the presentation of certain pairs of lines followed in random order).

We also discovered an unexpected phenomenon. In the interval of uncertainty participants tended to respond faster when comparing pairs of stimuli they had previously seen. To eliminate the influence of the learning effect, we compared the response time of the first presentation of a certain pair of lines to the response time of the previous presentation in the experiment (other presentations related to the same zone, and not the first). The average response time for the first presentation of a certain pair of lines is equal to 3005 ms, and the average response time for the previous pairs of lines is equal to 2696 ms. The difference for such pairs of response time is statistically significant (Wilcoxon test, $p<0{,}005$). We conclude that the first appearance of a certain pair of stimuli is perceived as a new problem. Once solved, this problem can be easily identified again.

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Cognitive styles determine observer's strategies in solving sensory tasks

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The study examines the contribution of cognitive styles (leveling–sharpening, equivalence range, augmenting–reducing, flexibility–rigidity of cognitive control and focusing–scanning) to solving sensory tasks and highlights individual differences in observer's sensory performance.

In accordance with the subject – oriented approach in psychophysics (K. V. Bardin, A. N. Gusev, I. G. Skotnikova) and the theory of activity (A. N. Leontiev, A. G. Asmolov), we consider the contribution of both subjective and stimulus variables: the activity of a person solving sensory-perceptual task as well as stimulus determinants of the observer's performance. Based on these approaches we believe that cognitive styles make up the functional organ, or functional system (according to A. N. Leontiev, A. A. Ukhtomskiy) of sensory tasks solving.

Moreover, we believe that cognitive styles affect the observer's choice of strategies while solving sensory tasks of different types.

Graduate and postgraduate students performed a set of cognitive style tests as well as two sensory tasks: (1) modified visual signal detection task, where a distractor was added to the original "yes–no" procedure; (2) audial signal discrimination task in "same–different" paradigm. We applied a quasi-experimental design. Sensitivity, response bias, reaction time and confidence were dependent variables, whereas independent variables were represented by cognitive styles listed above, as well as type and difficulty level of sensory tasks.

The results indicate that cognitive styles determine strategies chosen and used by a subject.

A high level of perceptual uncertainty is inherent to various sensory tasks in psychophysical studies. As a result, the observer is forced to somehow compensate or overcome this sensory deficit in order to solve the task successfully. Cognitive styles regulate the way of solving the task through the selection of appropriate means and strategies.

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Stress diagnostics and treatment are possible on the base of homeopathy and psychophysics unification

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Stress diagnostics and the subsequent anti stress therapy were conducted in 26 patients of a private dentist's office. Just before the dentist's primary consultation a selection of patients was conducted on the grounds of the presence of mental stress caused by the forthcoming pain expectation during stomatological interference.

The initial level of stress was determined with the help of a psychophysical experiment (the 1st session, see table 1) carried out with the help of the authors' licensed technique[1] on a computer. Stimuli: 2 horizontally oriented line segments presented for 5 seconds. In 25 trials the lines were of the same length (blank trials), in the other 25 trials they differed by 10% (signal trials). The presentations of the same and different pairs of lines and their positions on the computer screen were random. The patients discriminated the lines in the pairs to be the same or different. Then the patients were given a single-stage complex homeopathic medicine: stress-san (valerian C6, ignazia C30, passiflora C12). Each of the medication ingredients is an independent homeopathic medicine, well-reputed in a stress treatment for a long time already. The 2nd experimental session was conducted in 10–15 minutes after the medicine taking in. Then the patients received dental treatment. The 3rd session was carried out in 3 days after completing the dental treatment. Table 1 shows the average data obtained (1300 trials for each index).

Table 1

Psychophysical indices reflecting the dynamics of stress reaction
Sessions: 1) Initial, 2) After stress-san intake, 3) 3 days after the dental treatment

	P(H)	P(FA)	d'	RT	P(Miss)	Pn
1	0,8	0,22	1,61	1,879	0,21	0,51
2	0,82	0,14	1,96	1,31	0,18	0,45
3	0,8	0,15	1,88	1,274	0,2	0,43

Notes: P(H) – proportion of hits, P(FA) – proportion of false alarms, P(Miss) – proportion of misses of the signal (of the stimuli difference), d' – discriminability index, RT – response time, Pn – a decision making criterion index[2]. Pn=P(FA)/P(FA)+P(Miss).

The results obtained showed the following after stress-san intake: 1) a decrease of false alarms proportion and a subsequent increase of discriminability index d' together with a decrease of decision making criterion index Pn, 2) a response time decrease. Low initial discriminability level together with the high criterion and response time levels may reflect the patients' tension (stress) before the dental treatment. And the discriminability increase together with the criterion and response time decrease after stress-san intake may reflect the patients feeling relaxed and subsequently more comfortable, attentive, which made the observation more precise. Thus sensory performance improving was found in the patients after stress level decrease due to stress-san administration.

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ABX discrimination task: influence of semantic and perceptive categories

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ABX discrimination task has been used in categorical perception study in visual modality (emotional expressions) since N. Etcoff[1]. Results of ABX task are traditionally related with the effect of categorical perception, i.e. increasing of distinction on the boundary between semantic categories. In 2007 D. Roberson supposed that results of ABX discrimination task may be explained in terms of category adjustment model, introduced by J. Huttenlocher. D. Roberson, however, supposed that categories, relevant to ABX and category adjustment model are certainly semantic categories. The essential principle of analysis in this study is comparing proportion of the wrong answers X=A and wrong answers X=B. Effect of categorical perception itself does not predict any differences in the number of wrong answers. According to Roberson, category adjustment model predicts, that if A is closer to the center of category, than B, wrong answers X=A will be given more frequently, than wrong answers X=B[2].

In 2011 R. Hanley and D. Roberson analyzed many experiments and concluded that differences in wrong answers are present in all studies, but these results cannot be interpreted in relation to semantic categories. They interpret them as evidence of specific strategies, not related with real structure of categories, used by participants[3].

Results of our experiments[4], analyzed in terms of the asymmetry of wrong answers, demonstrate generally the uniform pattern: the stronger the increase in the proportion of wrong answers X=A is, the closer A is to the center of category. This was observed for transition series, based on emotional expressions (happiness, anger, fear, disgust, surprise, sadness); faces with modified size and distances of eyes, mouth and nose; series based on faces of different races. Neutral face itself does not evoke asymmetry of wrong answers.

Our interpretation of the observed results of ABX task is related to both perceptive and semantic categories. We suppose that belonging to different semantic categories increases performance due to the effect of categorical perception, and at the same time belonging to the same perceptual category decreases performance due to the perceptual magnet effect. Both semantic and perceptual categories are not rigid, their structure and content may be adjusted during a relatively short experimental study. Asymmetry of wrong answers in ABX discrimination task is the essential characteristic, which directly depends on the used stimulus and presentation conditions.

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Do grass snakes discriminate between green and red colors? (Development of a conditional reflex in a T-maze)

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We studied the capacity to discriminate between colors in 4 individuals of grass snakes (Natrix natrix) by ethological methods[1]. The snakes' behavior in a T-maze (T-shaped labyrinth) with removable lightened color cabins (heated green and not heated red) was studied. Cabins were placed to the right and to the left at the end of a long corridor. Air temperature was +19°C, in the warmed-up cabin +24°C. The duration of the experiment was not fixed: the experiment finished when the animal stopped for longer than 1 minute. The air in the cabins did not heat up more than by 1–2°C due to heating floors. Therefore it is possible to exclude reactions, induced by a thermo aesthesia in the snakes studied since they have no special thermo touch bodies allowing to feel apart warmth[2]. Illumination intensity was 70 and 80 lx at exits from the red and green cabins correspondingly, in the case when 13 W fluorescent lamps were put at the sides of the cabins, and 12 lx in the case when lamps were put on the cabin ceilings; 40 lx in the case when 60 W filament lamps and 12 lx in case of color fluorescent lamps and transparent cabins.

Results obtained. In the first 4 experiments the results showed that after hibernation grass snakes moved towards the red cabin and chose it. Development of a conditioned reflex[3] (the heated green cabin choice) was observed when two stimuli were presented more than 4 times (cabins colors – a conditional stimulus, and green cabin heating – a marginal stimulus). The number of the green cabin choices (65%) showed the reliable effect manifested at 99% significance level (χ^2=8,37, df=1). Directions chosen by snakes when driving were approximately identical (they showed the reliable effect manifested at 95% significance level: χ^2=0,07, df=1) for the right- (51%) and the left-hand (49%) sides of the labyrinth – in our case of the green cabin heating. The whole time spent by the animals in the labyrinth was 3,8–4,8 min on average in case of an incorrect choice and search behavior manifestation. It differed by 0,2–0,4 min from that in case of a correct choice in the same animal. After the cabin shifts, in 75% cases the snakes at first turned their heads in the same direction in which they moved in the previous experiment, but only in 25% cases they moved further, changing the direction more often. In case of the incorrect choice search behavior of the snakes was often observed (in 77% cases), which stopped in 95% cases because of the heated cabin finding. It may be related to forming an association of the cabin's color and its heating, which is necessary for the conditioned reflex development. On the basis of the research conducted, it is possible to suggest that the conditioned reflex of driving towards the light of the green range was developed in the group of grass snakes studied (Natrix natrix), i. e. these animals can distinguish between objects of green and red colors and remember them. Correctness of this suggestion as compared with other explanations of the results obtained will be verified in our further experiments.

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