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INTER-ANALYZER INTERACTION: THE OPERATIOZALIZATION OF THE CONCEPT IN RUSSIAN RESEARCH

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Abstract

The given article is dedicated to the research of inter-analyzer interaction (IAI), which is one of the manifestations of the integrative activity of the brain. The IAI problem is of special significance in the clinical - psychological context, due to the empowerment of psychology in the field of studying the syndromes of one's mental impairment in case of mental, neurological and somatic diseases.

Physiological and psychological approaches, methods and indicators of intersensory relations used in them are presented in this article. Studies of the physiological mechanisms of IAI in humans are described. Interaction of analyzers is considered as one of the manifestations of preset reactions that prepare the organism for actions in a constantly changing environment.

In psychological studies, the importance of the interaction of analyzer systems is stated and emphasized. However, in some experiments the concept of IAI is not usually operationalized. Issues related to the nomenclature and methodologies that assess the state of IAI are also controversial.

The authors state the adequacy of using the method of Uznadze, the formation of a fixed set as a tool for assessing the state of IAI in cases of disorders of integrative activity of the brain.

Keywords: Clinical psychology, inter-analyzer interaction, methodology of fixed set.

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1. Introduction

The problem of the integrative activity of the human brain has become interdisciplinary and one of the central in the whole network of modern neurosciences. In clinical and clinical-psychological aspects, there is a growing interest towards the studies of impairments in this activity. One of the manifestations of integrative activity of the brain is the interaction of analyzers. Cerebral hemispheres are a complex of constantly interacting central elements of afferent systems, which is manifested, for instance, in intermodal, inter-analyzer interaction.

It was in his study of the reflex laws of the cortex of the cerebral hemispheres when I. Sechenov (1952) defined the notion of the dynamic integration of its various structures for implementing integral activity for the first time. This idea was further developed in the works of Russian physiologists, I. Pavlov (1911) (cit. ex. 1949), A. Ukhtomsky (1978) and others who experimentally confirmed the presence of irradiation of nervous processes in the structures of the cortex of the cerebral hemispheres and considered it one of the fundamental mechanisms of interaction between various functional systems.

IAI has its own qualitative and quantitative characteristics, which can quite naturally change in the course of a disease and reflect changes in the functional state of the brain. Interaction of analyzers is normalized with positive dynamics of pathological manifestations (Fejgenberg, 1955). In a number of cases, IAI can be an additional criterion for assessing the effectiveness of various treatment and rehabilitation measures. Stable changes in the inter-analyzer connections can indicate a disturbed functional state of the central nervous system (CNS) and higher mental functions (HMF), even with a poor or completely absent neurological picture and be considered as an indicator of an unfavorable recovery prognosis.

1.1. Physiological methods and indicators of intermodal interaction.

In Russia, I. Sechenov, who proposed a reflex theory of mental reflection, posed the question of the relationship between different types of sensitivity for the first time.

The scientist has shown that human ontogeny forms various connections that unite anatomically different sensory organs into a single functional system. Sechenov's recognition of the relationship of sensations had a great influence on the further development of both physiological and psychological concepts of sensory reflection and cognition, where the autonomy of analyzer systems in relation to each other was accepted as a dogma.

The general ideas of the Sechenov were developed further in the works of I. Pavlov. The researcher emphasized that a more perfect balancing of the internal environment of an organism with a diverse nature goes simultaneously and inextricably with the development of analyzer activity and the nervous system. He gave the main role in the implementation of this process to the cerebral hemispheres. Trying to understand the basic mechanism of the operation of the cerebral hemispheres, the scientist suggested a natural-scientific way of studying the CNS through conditioned reflexes (Pavlov, 1949).

Students of I. Pavlov (N. Kasherininova, N. Krasnogorsky, F. Grossman) exhibited the phenomena of generalization and irradiation of neural processes in the structures of the cerebral cortex.

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With the progress of the scientific thought in this direction, there started to appear the works in which neurophysiologists and psychophysiologists studied the features of intersensory connections in various brain diseases.

In experimental physiological and later clinical physiological studies, an attempt was made to elucidate the cortical (not peripheral) nature of the mechanisms of interaction of analyzers in terms of the indices of the main processes occurring in the cerebral cortex - arousal and inhibition. Basing on the ideas of I. Pavlov about the cerebral cortex as a complex of analyzers the elements of which are in constant interaction with each other, thus forming a single functional system, the researchers suggested that pathological changes in the central nervous system should also be reflected in the violation of inter-analyzer connections (Fejgenberg, 1955). These changes were detected either by recording the electrical activity of the corresponding zones of the cerebral cortex, or by measuring sensory thresholds. The interaction of analyzers was studied in patients suffering from head injury, epilepsy, hypertension with dynamic disorders of cerebral circulation; stroke, alcoholic delirium, organic lesion of the diencephalic region, reactive states (Gulyamov, 1957; Gaponova, 1960; Fejgenburg, 1975).

As an example, we present several studies of the interaction of analyzers, which are of considerable theoretical and practical interest. N. Gavrilova (1958) studied the interaction of analyzers through electroencephalography, whereas the changes in inter-analyzer relations were estimated by changes in the brain action currents of the cerebral cortex, advancing under the influence of light applied sequentially against a background of "quiet", "medium" and "loud" sound. As a visual stimulus, intermittent light of increasing brightness was used.

I. Fejgenberg (1975) proposed another method of studying IAI that consisted in measuring the sensory thresholds of the central part of the visual analyzer. Electrical stimulation of the eye was carried out using a condenser chronaximeter. Then an olfactory stimulus was used with the help of an olfactometer (in some cases an auditory stimulus was used). The change in the level of optical chronaxy under the influence of the dosed adequate stimulation of the olfactory analyzer with thymol vapors (or the auditory analyzer with a tone) served as an indicator of the functional state of the intersensory bonds. In the same work the author showed that the very fact of presenting instructions in the absence of real stimulation of the receptor surfaces, causes changes in intermodal relations.

Thus, physiologists that include or exclude the stimulation of the peripheral parts of the analyzers, showed inter-sensory changes occurring at different levels of their organization. The physical characteristics of the acting stimulus (the length and intensity of the light wave, the frequency and amplitude of the sound oscillations, etc.) always act as stimuli in physiological studies, their effect is expressed in the indices of sensitivity or in the electrical activity of the neurons of the cerebral cortex.

1.2. Clinical - psychological approach to the study of inter-sensory bonds.

In the psychological works analyzers played an important role in the formation of psychological functional systems and human consciousness (Teplov & Kravkov, 1935; Soloviev, 1971; Velichkovskiy, Zinchenko, & Luriya, 1973; Beltyukov, 1977; Nasonova, 1979; Lebedinskiy, 1985).

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Until now, there have been quite scarce domestic psychological experimental studies on the interaction of analyzers due to the lack of development of the basic terminological apparatus of the sphere under discussion.

The definition of the IAI itself remains ambiguous. In psychological research, this concept is replaced more often by over-modal re-encoding (transcoding). V. Nasonova (1979) states that "... the complex processing of incoming information is possible with sufficient formation of integrative systems of the cerebral cortex that provide inter-analyzer interaction," and the author herself defines the IAI as a "... recoding of perceptual stimuli from one modality to another ... " (p. 17). As a tool for the study of transcoding, the author employs the modified technique of A. Luriya on the auditory-motor coordination. For correct motor performance of rhythmic tasks, in addition to acoustic samples, visual patterns of rhythmic patterns (coming as dots) were also presented. The reproduction of rhythmic tasks in each sample was preceded by verbal instruction and training, whereas the experiment itself was aimed at analyzing the cross-modal transcoding (from acoustic to motor, from acoustic to visual). The indicator of the successful completion of the task in each sample was the number of correct answers from the total number of possible ones. The given experiment confirmed the author's suggestion that "... the organic lesion of the CNS with the mental retardation in children is accompanied by the inadequacy of the processes of integrative processing of perceptive multimodal information, expressed to a greater or a lesser extent" (Nasonova, 1979, p.25).

Moskalenko (2014) argues that currently there is a significant increase in the number of studies devoted to the problem of cross-modal interactions in cognitive psychology and neurophysiology. As one of the possible mechanisms for their implementation, semantic congruence (consideration of multimodal stimuli from the point of view of coincidence of their values (Doehrmann & Naumer, 2008) is usually highlighted. In E. Moskalenko's opinion, the role of the interaction of modal characteristics of information in recognition is not sufficiently studied. In her experiment the author studies the recognition of verbal and imagery stimuli, presented in cross-modal and unimodal relations. 10 stimuli (verbal / imagery) of different modalities (visual, auditory) were presented for memorizing. Then they were presented in random order among 20 distractors. The participant had to answer "yes" if the test stimulus was identical to the stimulus required for memorizing and "no" - if it was not identical. Modalities and form of presentation of the material were varied (verbal / imagery) upon memorizing and revising. "The term cross-modal, cross-objective recognition ... denotes an experimental procedure for recognizing congruent specific verbal and / or shaped stimuli, in the performance of which the condition of presentation (modality, presentation form) during memorization and subsequent testing are different; the term unimodal, unicomponent recognition is the procedure for recognizing identical specific verbal or imagery stimuli, in which the conditions for presentation (modality, presentation form) do not vary during memorization and subsequent testing" (Moskalenko, 2014, p. 7). Thus, the cross-modal interaction is considered as one of the IAI types, and the experimental procedure for the cross-modal recognition as a possible way of studying the interaction of afferent systems.

An interesting study was conducted by a group of psychology students (Demina, Solodchik, & Khokhlov, 2014), in which it is the inter-sensory interaction that is analyzed, its “invisible presence” is not ascertained. Not giving the definition of IAI, the authors decided to check whether the controlled

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change (inversion) of the visual asymmetry affects the auditory asymmetry, that is, the IAI was operationalized through the indicators of sensory functional asymmetries. In order to influence the visual asymmetry, a prismatic pseudoscope was used. The study of auditory asymmetry was carried out using the method of dichotic listening, which was conducted before and after using the experimental pseudoscope. Authors estimated how many subjects in each group after wearing the pseudoscope changed the sign of the coefficient of the right ear (CRE) to the opposite, reflecting the inversion of the auditory asymmetry.

There is also an inquiring study of L. Arana-Larrea (1955), who approached the research of the interaction of the visual, cutaneous and motor analyzers through a peculiar quantitative indicator - the magnitude of Charpentier illusion.

It turned out that the magnitude of the illusion directly depends on the volume and mass of a larger object. Using the obtained data, the author makes an important assumption about a certain tonic readiness of the muscles of the hands, which occurs before the objects are raised and brings the muscles of the hands into a state of readiness corresponding to visual signals about the material and dimensions of the perceived object. This assumption was confirmed by measurements of the electromyogram.

Moreover, when only one modality of presentation of objects (visual or tactile) is used, the objectivity of perception increases.

The interaction of analyzer systems in the process of perception and assimilation of oral speech was researched by the psychologist V. Beltyukov (1977). The author's attention was drawn to the interaction of the auditory and visual analyzers with the speech and motor ones. The author considered the main criterion for the formation of inter-sensory connections to be the correct recognition and pronunciation of phonemes or phrases.

The results of the conducted studies of children from the control group showed that the mastering of the pronunciation is not implemented spontaneously, but rather under the influence of the functions of the auditory analyzer: the authorization and control of the final result of the pronunciation leads to the formation of a system of links between the articulatory and auditory images of phonemes, which ultimately forms a single auditory-speech system in a human being. In this case, the speech-motor analyzer influences on the differential ability of the hearing.

The blocking articulation method was used in the experiment: visual information (lip-reading) and articulation of the stereotypical phrases (e.g. poems learnt by heart, counting) are performed simultaneously. The results demonstrated the importance of interaction of motor and visual aspects of speech analyzer. Moreover, the blocking articulation method results into persistent decrease in the intelligibility of speech in deaf people who are good at lip-reading and capable of expressive speech.

2. Problem Statement

The authors of the given article, using the theory of the national school of psychology by L.Vygotskiy – A. Leontiev – A. Luriya define IAI as the influence of the perceived image of an object in one sensory system on subsequent perception processes in other sensory systems, the result of this influence is the emergence of qualitative and (or) quantitative phenomena in the analyzers originally not affected by the stimulus. So, the question of using this definition in the experiment arises.

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Due to three interdependent reasons, it is not possible to evaluate experimentally only sensations in the psychological research of IAI. Firstly, despite the fact that the only source of perception of objective reality is sensations, the very reality surrounding the organism is never reflected in its structure of activity as a chaos of disparate sensations: it is represented in the form of objects (Uznadze, 2004). Such psychological phenomena as a consistent image, the constancy of the perception of color, size and shape, sensations in the phantom limbs, also indicate that the object of perception is the most important thing for a human, it remains unchanged with altered or absent sensations. The reverse example demonstrating the primary role of object perception in the organization of human activity is the case of agnosias that make a person virtually "blind" despite the preservation of elementary sensitivity (Luriya, 1962).

Secondly, if the sensations, as the content of the perception of a certain objective image, are numerous and independent from each other, then the object itself always represents a single whole. Numerous experiments of Gestalt psychologists confirm the postulate that the properties of parts (sensations) depend on the whole objective image, and not vice versa.

The correctness of the analysis of sensations through perception is confirmed in the experiments of Yu. Polyakov (1974). The author has shown that in patients with schizophrenia, the characteristics of sensations can change not generally, but depending on the structure of which perceptual processes they are considered.

Thirdly, psychologists will not be able to analyze the changes in the structure of activity studying only sensations, since they depend on the state of the corresponding analyzer systems, and therefore are not subject to development and carry no psychological content. Whereas the perception "... also implies an object that has nothing to do with the senses, and therefore the possibility of expanding perception in the direction of regarding an increasingly more common object as its image is infinite. It depends on the level of one's mental development. Consequently, along with mental development, there is also the possibility of perception development "(Uznadze, 2004, p. 202). L. Vygotskiy (1982) also spoke on the constant development of perception in the process of human life, introducing such properties as orthoscopy and meaningfulness.

Thus, psychologists can only use objective stimuli in their studies, that is, work with the modality of the stimulus presentation, rather than the modal specificity of the stimulus.

There is one more important aspect in the analysis of IAI - the criterion for estimating intermodal rearrangements in the human perceptual sphere.

It was previously indicated that the image of an object is always polymodal. This means that the sensations from different analyzers complement each other, if the subject perceives an object in only one of the sensory spheres.

In order to study IAI within a psychological experiment, it is sufficient to choose such properties of the stimulus (attributes of the object) that can be perceived by a person through different analyzers. In other words, the qualitative results of the work of different analyzer systems (color, sound, smell, temperature, pressure, etc.) should have a common basis (properties of the object).

In their studies, physiologists considered the presence of preset reactions (based on the probabilistic structure of past experience and information on the actual situation) to be the main biological significance of changes in the physiological parameters of some sensory systems during stimulation of

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others. One of the stages of the preparations for action in the new situation is the restructuring of sensory function. As a result, the collection of information regarding the changes in the environment surrounding the organism is improved. The result of intermodal rearrangements is the mobilization of some afferent systems and the demobilization of others (Fejgenberg, 1975).

The psychological counterpart of these preset reactions is a fixed set (Uznadze, 1930), and one of the possible psychological experiments that allow studying IAI is the procedure of the formation of a fixed set. The works of D. Uznadze and his students proved that the set is not local in nature, it rather represents an integral mental state that possesses the properties of generalization and irradiation (Adamashvili, 1958; Avalishvili, 1958). The latter is manifested in the possibility of transposition of the plant from one correspondent organ to another, and from one modality to another, that is, the elaborated system as a result of the effect of the objective image in one sensory region mediates further perception processes in other analyzers.

3. Research Questions

In their studies, physiologists considered the presence of preset reactions (based on the probabilistic structure of past experience and information on the actual situation) to be the main biological significance of changes in the physiological parameters of some sensory systems during stimulation of others. One of the stages of the preparations for action in the new situation is the restructuring of sensory function. As a result, the collection of information regarding the changes in the environment surrounding the organism is improved. The result of intermodal rearrangements is the mobilization of some afferent systems and the demobilization of others (Fejgenberg, 1975).

4. Purpose of the Study

Given the position outlined above, our working hypothesis relies on the proposition that psychological methods that allow detecting and analyzing the disturbances of IAI of neurological and psychiatric patients present the methodology of Uznadze: the formation of a fixed set.

5. Research Methods

Experiment procedure:

Instructions for a bimodal experiment: "On the laptop screen you will be quickly shown two balls: one on the left, the other one on the right. This will be repeated a certain number of times. Upon each presentation of the balls you need to compare their size. If it turns out that one of the balls is bigger (even slightly) than the other, say which side the bigger ball was – the left one or the right one. If they seem equal to you, say "equal." After that, I'll blindfold you and ask you to put your hands on your lap, palms up. I'll put the balls in your hand a certain number of times. Your task is to compare the balls in size and answer in which hand the ball is bigger. If they seem equal to you, say "equal." Upon moving to the critical series in the tactile sphere, we repeated the instruction to the subject, adding: "Compare the balls to each other and say which one is bigger or whether they are equal."

The objects exhibited to the participants for comparison are either two red balls on a green background, displayed on a laptop screen, or two wooden balls put in the palm of a person.

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The experiment includes two series: set (balls of different diameters (95 mm and 55 mm, 50 presentations on the laptop screen) and critical (wooden balls of the same diameter (55 mm), 50 presentations in the palm of a subject).

In the installation series, a fixed set is formed in the visual perception (see Figure 01).

The total exposure time of stimuli on the laptop screen is 2000 ms.

In a critical series of experiments, tactile illusions of size are recorded.

A critical series of experiments is conducted without visual control (the subject is blindfolded), and a chin rest is used to stabilize the person's head in a single line.

In order to maximize the isolation of the tactile analyzer from the motor one, the respondent's hands lie on their knees, palms up, which allows only to feel objects and make size estimations. The participant, covering his fingers with the surface of balls that the experimenter holds by the wooden handles, could compare their size without knowing their gravity. Since the mass of both balls was equalized (to 99 grams), the probability that the respondent will take into account the difference in pressure exerted by the balls on his palm was minimized. Such methods made it possible to limit the impact of compared balls to only one tactile modality.

The perceived size of items was judged according to the oral report of the participant. If in the critical series up to the fiftieth exposure inclusive the respondent did not get out of the influence of a fixed set, the experiment ended.

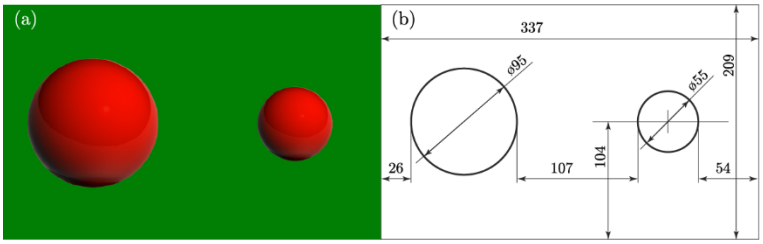

Figure 01. A photograph (a) and a drawing (b) of balls of different diameters, presented visually during the set series of the experiment

6. Findings

The article is theoretical and authors main focus is variety of experimental examination of IAI in a clinical psychology framework. Therefore author didn't include the description of the experiment design and analysis of the experimental data.

7. Conclusion

In conclusion, future psychological studies in the field of intermodal interaction can significantly expand the possibilities of clinical psychology and reveal new perspectives of researching clinical and psychological syndromes in various psychiatric, neurological and somatic diseases. Investigations of the features of intermodal connections in healthy people will make it possible to identify the dependence of connections in the sensory spheres on the specifics of the HMF and thus to approach the development of criteria and range spread of the mental norm. This particular aspect brings the problem of the integrative activity of the brain beyond the frames of clinical psychology, making it interdisciplinary and important

for the solution of issues of vocational guidance and vocational selection, training programs, as well as management in case of underachievement. The method of Uznadze, the formation of a fixed set, allows to operationalize the IAI through such an indicator as illusions. Fixing the number of illusions and the dynamics of the set in sensory modalities, one can draw conclusions about the state of IAI in subject.

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