

## Intellectual emotions

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In the laboratory of O.K. Tikhomirov, the phenomenon of the acute emotional regulation of productive thinking was justified. This regulation is realized by means of the elaboration of the axiological profile of cognition. The following definition of intellectual emotions can be given: intellectual emotions are the appraisals of specific cognitive objects — contradictions, assumptions, probabilities, and the intermediate and final results of operations. The main aspect of the method used in the research consisted of the synchronous registration of an external (tactile) elaboration of problems, skin galvanic response and verbal utterances regarding tasks to be completed in a game of chess. The principle position in Tikhomirov's group is the following: intellectual emotions represent not only the energetic resource or catalysts for the thinking process, but also the determinants of its structure.

**Key words:** Intellectual emotions, thinking process, cognition, emotional appraisal, galvanic skin response, blind chess players, anticipation, emotional regulation, emotional heuristic, insight

The program thesis of L.S. Vygotsky, which implies that human thinking is the *unity of emotions and intelligence*, was implemented in the study of *intellectual emotions*, which was developed by O.K. Tikhomirov. Theoretical and methodical results of Tikhomirov's research group were published beginning in the late 1960s in a prominent number of scientific journals and collective monographs (edited by Tikhomirov).

The domain of the psychology of thinking which was developed by Tikhomirov and his colleagues was significantly different from widespread conceptions regarding thinking, such as: the mathematical theory of rational decisions (Kozeleckij, 1979); operational theories, such as "General Problem Solver" (Ernst & Newell, 1969); the theory of heuristic structures (Doerner, 1976) and from the "Cognitive Science" (Norman, 1981).

Tikhomirov, relying on empirical data, claimed that human thinking couldn't be thought of as a "computation", which is performed according to an algorithm. He argued, first of all, against the then-popular analogy of "artificial intelligence" to "human intelligence". Tikhomirov's arguments for the qualitative specificity of human thinking were based on a huge amount of data on goal formation and in-

tellectual emotions in the regulation of problem solving, which he acquired in a series of experiments which were conducted on various samples. A.N. Leontiev's specific concept, which can be translated as "Engagement" (Vasilyev et al., 1980, p. 19) or "Partiality" (Tikhomirov, 1988, p. 92) could be applied to the aforementioned data.

The "Intellectual emotions" research program can be considered a contribution to the development of the scientific problem of connecting cognitive processes with physiological ones (particularly the reactions of a vegetative nervous system).

Intellectual emotions were paradoxically considered in psychology for a long time without their emotional component being taken into account. The connection of intellectual emotions with the motives, interests and needs of a person was established only in works of L.S. Vygotsky, S.L. Rubinstein and A.N. Leontiev. These authors emphasized the integration of cognitive and emotional processes, which was manifested in such units of psychological analysis as the subjective reflection of an object (sense).

A.N. Leontiev explicitly claims that human activity is in principle "partial" (engaged), and that therefore it is regulated by emotions. Emotions are the psychological means of presenting a motive to a subject: one can recognize his or her motive through the emotions he or she meets with. This phenomenon is called the "*incentive function*" of emotions. Emotions are relevant in that they function only for the entire activity of a subject, but not for its subordinated units, such as actions and operations. Emotions also possess an *orienting function*, as far as they are the signals of the development of personal senses of what the situation and action components are.

Vasilyev (1976, p. 151) defines intellectual emotions as appraisals of the thinking process. That definition can be amplified: subject-object relations, which are developed and reflected in the thinking process, are appraised in intellectual emotions. If we consider thinking as an activity, according A.N. Leontiev's approach, this relation can be understood as a motive-goal relationship, or a personal sense. Leontiev characterizes emotional appraisal with the metaphor of "coloring". Emotional coloring has its own *intensity*, *sign* and *quality* (Vasilyev et al., 1980, p. 32). Emotional appraisal is not originally verbally delivered, but it can get verbal formulation later in the course of mental activity. Emotions are the indicators which present to our consciousness immediately the motivational meaning of unconscious psychic components.

Another question is how emotions take part in the thinking process. This question wasn't originally developed in western experimental psychology. Two different topics were elaborated in the investigation of intellectual emotions in Tikhomirov's laboratory. The main topic was the functional analysis of emotional activations in the thinking process. Emotional activations were measured as changes of heart rate and galvanic skin response. These physiological parameters were considered synchronically in connection with states of the problem field, with verbalization and eye movements, and with the movements of blind chess players. The second topic was the description of phenomenon and the classification of intellectual emotions. These two topics were united in the research of O.S. Kopina (1982).

The parts of verbal protocols of problem solving that are synchronous with vegetative measures are considered phenomenal data for the indication of intellectual

emotions. This data allows for the operationalizing of the development of senses, which is reflected in the dynamics of intellectual emotions. The main research questions are connected with the analysis of conditions, under which intellectual emotions emerge and with the regulatory functions that emotional activation fulfills in the processes of problem solving.

### **The method of functional analysis of intellectual emotions**

Tikhomirov's experimental paradigm of functional analysis implies the registration of emotional activation patterns synchronous with the microanalysis of thinking activity in the course of problem solving. Skin galvanic response (SGR) and heart rate are the physiological indicators of patterns of emotional activation. The Fere method was used to measure skin resistance (by Sokolov, 1963, 54) with two zinc electrodes put on the surface of the palm.

The results of the experiments (Tikhomirov, 1969; Vinogradov, 1975) justified that skin galvanic response is an indicator of emotional activation and emotional activation's influences on the success of problem solving. While the influence of situational emotions can be considered as an amplifying or extenuating factor (Mandl & Huber, 1983), intellectual emotions emerge intrinsically in thinking process and take part in its personal regulation. The research program, which is dedicated to the study of intellectual emotions, is aimed at proving that they do not only change the thinking process with respect to some energy level, but also its structure.

### **Skin galvanic activity in the process of problem solving**

In the experiments of Tikhomirov and Klochko (1976, p. 176-205) skin resistance regularly *rose* when some problem occurred during the course of some mental activity. This problem forced the subject to make a delay (pause) in the solution process and change the direction of his activity. The resistance of skin rose during a search for a contradiction (in text) as well. When the contradiction was discovered and formulated, the resistance of skin declined.

Tikhomirov (1983, p. 166) wrote that via the preconscious appraisal of uncertainty, the actual acting set was weakened. The set weakened more with every address to the contradictory place in the text. This pattern took place until the original activity was not given up and the goals of a new activity were set.

The connection between intense anticipation, which is reflected in vegetative inactivation, and emotionality, is not clear enough. Authors have supposed that the arousal of sensitivity to contradictions (in text) took place as a consequence of the emotional coloring of certain places in text. Then another question occurs: what type of emotional coloring is vegetative inactivation connected with?

Klochko (1979) connected the discovery of contradictions with processes related to goal formation. He formulated the following thesis: the emotional processes of appraisal, which constitutes putting current information about a situation into a certain profile, is the basis of goal formation.

### Emotional heuristic

The comparison of the moments of skin resistance decline with connection to various cognitive events was realized during a series of scientific studies. Tikhomirov (1975, p. 305) wrote about the heuristic functions of intellectual emotions and Vekker (1981, p. 269) used the expression “emotional heuristic”. Emotional activation in these experiments took place regularly during moments when a problem situation was subjectively clarified to some extent: the contradiction, which the subject searched for and had anticipated, was identified and the subject could name it. Thus it was possible to explain and solve it.

If we generalize these results, we can say that emotional activation appears simultaneously with the insight within the search process in problem solving. The precise analysis of the emotionally-conditioned development of insights was elaborated in the series of studies conducted in Tikhomirov’s laboratory (Tikhomirov, 1969, 1975; Vinogradov, 1975; Terekhov & Vasilyev, 1975; Vasilyev et al., 1980).

### Method

All of the aforementioned studies were carried out using a sample of first-rate chess players, which solved different tasks in chess. An important advantage of these tasks was that both the researcher and the player understood the conceptual framework. Thus, chess tasks were accessible for analysis. The researcher could precisely define the stage of the problem’s solution and the possibilities of advancement in each moment. Through separate manifestations of behavior (fragments of speech, movements of eyes or tactile movement, which reflected the subjective fixations of chess fields) it was possible to make a conclusion about the considerations and intentions of a subject.

Tikhomirov (1969, 1975) worked with a specific sample of blind chess players because of the opportunity to externalize preverbal phenomena. Blind chess players had to examine the chess configuration with their hands. It was demonstrated that tactile preverbal manifestations prepare verbal expressions of thinking. This method was developed in Terekhov’s dissertation and then used in the works of Terekhov and Vasilyev (Terekhov, Vasilyev, 1975; Vasilyev et al., 1980).

Chess players examined chess fields using the index finger of their right hand with an electric bulb fixed on it. The movements of the finger were recorded on film at four second intervals. The skin galvanic response was registered synchronously from the left hand and a record of verbal reasoning was made during the course of the problem solving .

### *Differentiation of regulative functions of intellectual emotions*

In the research of Vinogradov (1975) it was shown that emotionally neutral periods occur at the first stage of elaboration of chess etudes. Immediately after recognizing an initial situation would a chess player propose a solution which seemed to be the only correct one. Their reasoning was conventional at that stage of problem solving and skin galvanic response didn’t arise.

*Interpretation.* The hypothesis was that chess players were undertaking their first conventional attempts at conducting a better examination and understanding the situation. They could even anticipate these attempts to be unsuccessful and gave them up after trying.

Considerable skin galvanic response appeared straight away after certain exclamations (“What! Ah, stop!”) (Terekhov, Vasilyev, 1975, p. 111, 134). Skin galvanic response followed a verbal description of the insight. Tikhomirov (1983, p. 162) considered an “emotional solution” to be an indicator of an insight, which was a decisive idea about how to solve something. “Emotional development” reached its maximum at the emotional solution stage.

The revelation of the potential number of outcomes from a chess game had an emotional echo, since they were connected with possibilities, which were relevant to goals.

The emotional appraisal could conflict with the verbal appraisal of a certain way of finding a solution by moving a piece. Chess players often designated this move as hopeless. Nevertheless he returned repeatedly to it. The emotional appraisal often turned out to be more correct than the verbal appraisal (Vinogradov, 1975, p. 65).

During the course of searching for a solution which was executed imperfectly emotional activations with a negative sign accumulated in a strong skin galvanic response. This general emotional activation is prepared summary verbal appraisal “it is time to end up with this direction of search” (Vinogradov, 1975, p. 60; Terekhov & Vasilyev, 1975, p. 139).

Tikhomirov (1983, p. 163) summarized the function of negative emotions during the course of problem solving: “The emotions “switch” the subject to a new general plan at the moment when his certainty of that the old plan is wrong has not yet begun to be formed as a result of an explicit logical discourse.”

The regulative function of intellectual emotions is based on that fact that they make a profile of the problem situation in relation to goals. One may say that they produce the figure-background division as the child game “hot-cold” (Tikhomirov, 1975, p. 311).

Preverbal, *anticipative*, preconscious intermediate products of the thinking process have a special meaning. Can we strictly define the appraisal function of intellectual emotions, or is it a matter of intuition, i.e. cognitive functions?

*With respect to the question regarding the anticipative functions of intellectual emotions.*

There are two possible approaches to anticipative functions:

- 1) To define cases with outstripping emotional activation, in which skin galvanic response arises before corresponding tactile or verbal activation;
- 2) To define the cases of emotionally colored activity or cognition within an anticipative content.

If the intellectual emotions have an independent anticipative function, all anticipative functions (1) belong to cases (2), refer to tactile or verbal anticipations. To make such a conclusion, the following presupposition is necessary: the anticipa-

tive intellectual emotion is a preconscious expectation, which must be formulated. In this case, emotional activation realizes the function of a regulative emotional anticipation.

Anticipation can be defined as a cognition, which points to a latter cognition (Matthaeus, 1988, p. 596). Therefore the anticipative cognition opens some dialogic cycle: a question — an answer, a point of view — the appraisal of a point of view (Kuchinskiy, 1983). The problem solver is the single initiator of the solution to such types of problems (chess tasks). He can expect a solution only from himself. Therefore he relies on himself when he elaborates the anticipation: by some intention, he must realize it, by taking a guess he must solve it, by some question he must answer it.

Intellectual emotions are connected with different cognitions in the problem solving process. If these cognitions are arranged according to the phases of the problem solving process, we can establish the following list:

- 1) Goal setting, specification of goals and repeated actualization of goals (Vasilyev et al., 1980, p. 150);
- 2) Intermediate goal formation (p. 98, 150);
- 3) Formation of particular goals (p. 98, 135, 137);
- 4) Formation of intentions, connected with the realization of particular goals (p. 102, 135, 150);
- 5) The formation of a hypothesis and its appraisal in relation to an intention (p. 88, 90, 102, 136, 137, 150, 151);
- 6) Analysis of the situation and discovery of important qualities of elements in the initial, transitional and final states of the problem's situation (p. 92, 102, 135, 137, 139, 148, 151);
- 7) A search for and the elaboration of barriers, as manifested in the possible chess moves of an opponent (p. 95, 102, 137, 139, 148, 150, 151);
- 8) Plan of action for the realization of intentions or for the realization of final goals (p. 93, 102, 135, 150);
- 9) Anticipation of achievement of particular goals (p. 135);
- 10) Negative or positive results of the attempts at a solution (p. 94, 96, 102, 137, 139);
- 11) Revelation of action which leads to the final goal (p. 137, 139, 151);
- 12) Subjective confidence based on the report on the solution (p. 139).

In this list, the intentions and hypothesis can be defined as anticipative cognitions. These are the cases of intellectual emotions with anticipative content.

Let us give an example of the development of an intention. The chess task (Fig. 1) can be solved in two moves. The chess player examines tactically the e3 square (white bishop) in relation with the squares d6 (the king of the opponent) and c7, b6. Nonverbal intention can be concluded from this interaction: pressure on the square c7 in checkmate zone with help of bishop b6 can be exerted.

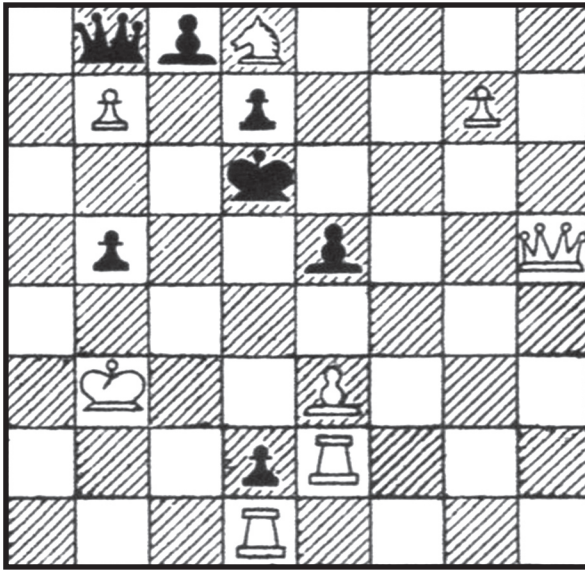


Figure 1. The two moves chess task. The solution is Be3:d2.

The dynamic of skin galvanic response is demonstrated on the Figure 2.

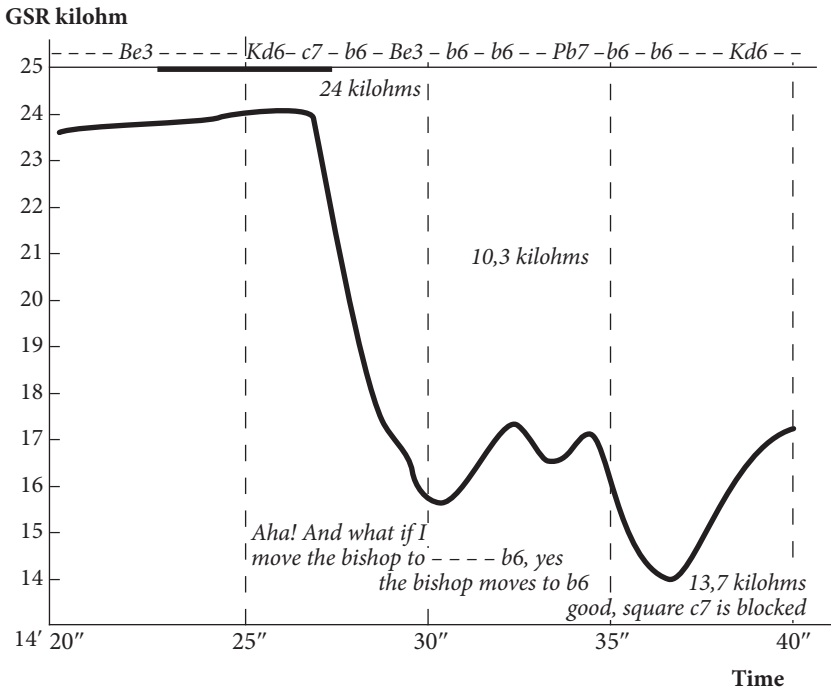


Figure 2. The fall of the skin resistance by the development of an intention.

Designations: top line, a record of tactile activeness using chess symbols; middle, the dynamics of the GSR; bottom, verbal utterances.

## Conclusions

1. In the laboratory of O.K. Tikhomirov, the phenomenon of the acute emotional regulation of productive thinking was justified. This regulation is realized by means of the elaboration of axiological profile of cognitions. The following definition of intellectual emotions can be given: intellectual emotions are the appraisals of specific cognitive objects: the contradictions, assumptions, probabilities, intermediate and the final results of operations (Vasilyev, 1979). Intellectual emotions consequently engage in the regulation of productive thinking. These emotions are different from emotions that are described as “emotion and cognition”. The latter emotions don't organize thinking, but disorganize it. These emotions narrow down the regulation of thinking to automatic responses.
2. The applied research method was complicated and deeply elaborated. The main point of the method consisted of the synchronous registration of the external (tactile) elaboration of problem, skin galvanic response and verbal utterances with respect to chess tasks, which were suitable for deep psychological analysis, including an accurate comparison of emotions and cognitions.
  - i. In case there was a high level of accordance between emotions and cognitions, cognitive phenomena could be registered by relying on the indices of vegetative activation.
3. The following position was elaborated in Tikhomirov's group: intellectual emotions are not only the energetic resource or catalysts for the thinking process, but the determinants of its structure. Intellectual emotions are the intimate regulators of thinking. These emotions indicate that cognitions have personal meanings to them.

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