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Technique for Studying Motivation Toward Scientific Activity: Development and Practical Application

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Abstract

Introduction. As our analysis has shown, the literature offers very few publications that address the issue of diagnosing motives for scientific activity in adult research professionals. Being guided by the principles of the meta-system approach, we developed the concept of motivation toward scientific activity as a theoretical foundation for the appropriate diagnostic technique. According to this concept, motivation toward scientific activity includes 10 various motivational subsystems (groups of motives) such as external, internal, value, cognitive, reflexive, and indirect ones, competition-, security-, and achievement-related motives, and anti-motivation. These subsystems are reflected in the corresponding scales of the developed technique.

Methods. A total of 944 research professionals at various research institutes, including universities, and commercial scientific organizations from different cities of the Russian Federation participated in this study. Exploratory factor analysis was employed to select tasks for the technique.

Results. The final version included 70 items (7 for each of the 10 scales), of which 25,71 % were 'reverse-worded' and 74,29 % were 'positive-worded'. The technique met the criteria of test-retest reliability ($r = .899$, $p = .001$), half-split reliability (Spearman–Brown: $r = .822$, $p = .001$; Rulon: $r = .814$, $p = .01$), and internal consistency reliability ($r = .814$, $p \leq .05$). The authors determined empirical validity of the technique by examining the relationship between scientific productivity and motivation. The Motivational Profile test by W. Richie and P. Martin was instrumental in testing construct validity. A Shapiro–Wilk test showed that the scores for each scale were normally distributed, which made it possible to use sten-score scales.

Discussion. The practice of psychological support of research activity at the RAS research institutes and R&D commercial organizations enabled authors to provide recommendations for chiefs, psychologists, and human resource managers for managing and optimizing the structure and level of motivation among research workers and increasing their labour productivity.

Keywords

psychodiagnostic technique, motivation toward scientific activity, research professionals, meta-system approach, subsystems, diagnostic scales, item analysis, reliability, validity, normalization of results

Highlights

► At the present time, there are no special psychodiagnostic tools for studying motivation toward scientific activity among research professionals.

► The developed diagnostic technique underwent all necessary psychometric evaluation and met all validity and reliability criteria.

► This is a fundamentally new original technique for diagnosing a wide range of motives for scientific activity in adult research professionals.

► Diagnosing the level and structure of motivation toward scientific activity opens new opportunities for purposefully stimulating scientific activity, taking into account the effects of systemic and time continuity, as well as a combination of individual and group stimulation.

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Introduction

The studies of need-motivational sphere of the researchers are actual today in both theoretical and applied aspects. Against the background of great attention to the studies of motivation of students' educational and scientific activity [1, 2,] and researching the content and processes of scientific activity [3, 4, 5], the methods of evaluating the motivation of scientific activity (hereinafter – MSA) in adults are not numerous, and they do not always take into account the specificity of this type of activity [6, 7]. In Russia, content analysis [8] or non-specialized psychodiagnostic methods of motivation are used to study MSA [9]. The author's original methods allow to study only certain aspects of the MSA, for example, its origin [10].

The listed problems of studying MSA caused the necessity to create its concept, which is methodologically based on metasystem approach, as one of the historically and logically conditioned branches of the development of the system approach [11]. MSA, being a system with a built-in metasystem level, includes a number of motivational subsystems (groups of motives), which together exhaust the entire list of potential motives of scientific activity. This is external and internal motivation [12, 13, 14]. Cognitive motivation [15, 16]. Motivation for success [17, 18]. Security motivation [19, 20]. Competition motivation [21, 22, 23, 24]. Value motivation [25]. Reflexive motivation partially corresponds to the construct of autonomous motivation [26, 27]. Antimotivation is studied for the first time in scientific activity [28, 29]. Indirect motivation. Ten motivational subsystems listed above formed the basis of the theoretical construct of the developed technique and its scales.

Methods

The development of the method included three standard stages of the development of questionnaire-like psychodiagnostic methods: item analysis, verification of validity and reliability, standardization. The first sample consisted of 326 people, researchers of RAS institutes and universities: average age: 40.7 years old, average experience of scientific work – 18.1 years. The sample of the second stage was 284 people, researchers of RAS institutes and universities: the average age was 46.15 years old, the average length of scientific work 21.5 years. The sample of the third stage consisted of 334 employees of scientific institutes and universities. The average age was 41.08 years old, the average length of research work – 17.04 years.

Results

Initially, 10–15 questions or statements reflecting its typical manifestations in scientific activity were made for each of the motivational subsystems. Questions and statements were "direct" in 75 % of cases and "reverse" in 25 % of cases. Each question or statement was evaluated by respondents on a standard 7-point scale from "absolutely true" to "absolutely incorrect".

The results of the first stage of the study were subjected to exploratory factor analysis to establish the ways in which the questions of methodology and theoretical factors (subsystems) correlate. Factor loads were calculated using principal component analysis (Annex 1). The final version of the method includes the questions demonstrating the values of 0.35 and higher according to [30]. If more than 25 % of respondents found the question difficult to answer, it was excluded. The selected 70 questions were included in the final version of the MSA (Annex 1) with 7 questions for each of the 10 scales. Of these, 18 (25.71 percent) were "reverse" and the remaining 52 (74.29 percent) were "direct".

Reliability of MMSA. Retest reliability check was carried out on a limited sample (49 people). Two tests were carried out at intervals of 6 months (Table 1).

Table 1. Retest reliability of MMSA

MMSA Scales	
External	,56
Competition	,72
Achievement	,68
Security	,79
Internal	,75
Value	,76
Cognitive	,91
Antimotivations	,58
Reflexive	,76
Indirect	,73
Total score	,89

Symbols: r – value of Pearson's linear correlation coefficient, at $p \leq 0.01$.

For most scales, retest reliability shows satisfactory values ($r \geq 0.7$). The exceptions are the "External", "Achievements" and "Antimotivation" scales, which correspond to our concept, assuming the presence of temporal dynamics and self-organization of the MSA's system on the basis of situational goals.

The reliability of the equivalent halves of the test was checked for both the total score (total MSA level), using the method of Spearman-Brown (0.83, $p < 0.001$) and Rulon's method (0.82, $p < 0.001$). The reliability based on the internal consistency or inter-consistency of the MMSA tasks was calculated based on Cronbach's Alpha for multivariate answers, which also showed satisfactory results (0.82, $p \leq 0.01$).

Empirical validity of MMSA. The information about the products of scientific work serves as an objective empirical indicator: the higher is the subject's MSA, the more productive he or she is, however: "...correlations are not too strong – in most cases they fit in the range from 0.20 to 0.30" [31, p. 153]. Given that "highly productive scholars are characterized by the orientation on scientific work and not on the career as such" [32, p. 159], the positive correlation relationship should be detected between productivity, the "Internal", "Cognitive" and "Values" scale and the scale of "Achievements" [33]. The results of the empirical verification of the validity of MSA (Table 2) confirm that they correspond to the listed theoretical and empirical regularities that that indicates MMSA's satisfactory empirical validity. The "Reflexive" and "Security" scales negatively correlate with the products of scientific activity because of the fear of error and the desire for self-control inhibits the growth of quantitative indicators of productivity, but contributes to quality improvement. The lack of interrelation of the work products with the "Indirect", "External" and "Competition" scales is theoretically justified, since these subsystems do not work to increase productivity directly.

Table 2. Correlation between indicators of productivity of scientific activity and MMSA

MMSA scales	Total number of works	Monographs	Papers in the journals included into the SAC list	Patents	Certificates	Citation Index	Works for the last three years	Conference presentations
External								
Competition								
Achievement	0,17*	0,15*		0,11**	0,11**		0,18*	0,22*
Security	-0,10**	-0,10**						-0,12**
Internal	0,22*	0,22*	0,11**	0,13*		0,15*	0,23*	0,17*
Value	0,19*	0,16*			0,12**			0,011**
Cognitive	0,18*	0,15*	0,19*	0,20*		0,13*	0,19*	0,20*
Antimotivation					0,11**			
Reflexive								
Indirect			-0,14**					
Total score		0,10**				0,11**	0,15*	0,11**

*Symbols: * – the value of the Spearman correlation coefficient, at $p < 0.05$, ** – the value of the Spearman correlation coefficient, at $0.1 \leq p \leq 0.05$. Minor correlations are not included in the table.*
Rationing of MSA was carried out using STEN-scores scale (Annex 2).

Using the Shapiro-Wilk test, the data for each scale and the total score for the test were tested for normal distribution. After that, the accumulated frequencies for each scale were calculated. Then with the help of the calculator in Statistica 6.0. the frequencies for the wall scale were calculated (Annex 2). The STEN-scores scale is most commonly used in psychodiagnostic techniques that allow comparative studies, and the dimensionality of the "raw" points allowed to do this: for each scale, the subject can score from 7 to 70.

The developed method allowed to study the structural-level characteristics of the MSA and their genesis in the process of professionalization of the researchers, this process revealed the fundamental laws of its functional organization. The method was used to audit staff in universities, research institutes and commercial R&D organizations [33, 34, 35]. As a result, a number of recommendations were made and their implementation allowed to optimize the socio-psychological climate and increase job satisfaction. Below we provide a number of recommendations on influencing various motivational subsystems.

As a rule, **external motivation** is generally stimulated by a cash reward because it includes material motives. However, extrinsic motivation also includes fame motives, needs for recognition, respect, status enhancement. This can be achieved due to a number of organizational factors (symbols, emphasizing the status, publications in the press, etc.). Of course, these motives are not operating for all the researchers and a number of them can, on the contrary, feel irritated and demotivated at these perspectives. That is why the issue of individual evaluation of the MSA system becomes a priority.

Security motivation involves avoiding failures and fear of rejection by the scientific community and achieving stability in the scientific organization. Usually the management of scientific organizations is trying to use the effect on this subsystem by "intimidating" employees with deprivation of bonuses, reductions, etc. For the effective research work the security subsystem must be neutralised, as it only hampers scientific thought and creativity. To do this, one needs to create conditions in which the employee will feel secure about his life tomorrow and today and cease to feel struggling for existence. If the primary goal of the scientist is to achieve the necessary survival financial minimum, he will not be able to focus on research. There is a need for a higher base salary and a minimum contract period of 5 years, since research cycles that can lead to serious results usually take long periods of time.

Competition motivation may have a positive impact on the results of work, if it is manifested at the inter-group level. Therefore, depending on the nature of the scientific work (if it is a group work), in each case it is necessary to introduce incentives connected not with the individual work, but with the results of the work of the group as a whole and to encourage the whole group. And it is desirable to make these incentives not of a material nature in order to stop attempts of their subsequent intragroup division and comparison, which provokes resentment and conflict. As a group reward one can use buying new equipment or moving into a new, more convenient room or having group business trips.

Reflexive motivation includes self-motivation, self-control, goal-setting, self-stimulation in scientific activity, i.e. self-organization of the scientist in scientific work and is more often higher in "reclusive scientists" who are well-known and respected in the scientific community, who are authorities, luminaries. However, their objectives may differ significantly from those set by management. It is quite difficult to manage this category in traditional incentive systems, since they are not interested in material bonuses. Such a scientist should feel that his right for exclusivity is recognized. There is a need for personal and informal contact between the manager and the scientist, who should see that his work is genuinely interesting. Such a scientist should be given independence and autonomy, the ability to carry out research, have a flexible work schedule, be mobile. Feeling respect and recognition from the management, he will strongly support the organization that appreciates him, including the provision of the necessary scientific products.

As a rule, individuals with high reflexive motivation also have high **internal motivation**, which is defined as intellectual and aesthetic pleasure from the process of scientific research; as far as scientific activity is the purpose, meaning of life, it gives a sense of fullness of self-realization and being. Therefore, all of the above methods of stimulating reflexive motivation are suitable for people with high internal motivation. It is necessary, however, to take into account that not all persons with high internal motivation also have a reflexive one (it is usually young scientists), and working with this group it is necessary to use other methods of motivational influence, contributing to their greater ability to be well-organized.

Value motivation provides the scientific activity with higher meaning, without which it cannot be carried out. Researcher must understand and keep in mind not only the immediate objectives and benefits from his work, but also the ones at existential level, there must be an understanding of why his research work is necessary both for him personally and for society, for mankind in general. Now the discussions about such values and such motivation are extremely unpopular, regarded as romanticism, lack of practicality. However, these are the values that guide scientific work and act as the motivational basis on which scientific activity is carried out, when all external incentives, including material ones, are absent or exhausted. It is important not to make a mistake here and avoid thinking that the presence of the value motivation compensates for all the other motives, which continue to exist: the scientist with a high value motivation also needs both financial incentives and recognition of his merits, etc. In the absence of value motivation, the scientist, sooner or later, comes to the idea of the meaninglessness of his work and either just drops it or starts pretending he is doing real work. Due to the general disapproval of humanistic values, scientists who share them and try to implement them in their work, try not to advertise it. At the same time, the need to implement the highest values in the work is present and manifested most often in the desire to transfer one's knowledge, to create a group of like-minded people. Because of this, many scientists are beginning to actively engage in teaching. In part, humanistic motives can be implemented in contractual activities, when scientists work on a specific order, they see that their work is needed by specific people and then can be convinced of its real use. This is often not possible in grants and that's the reason why many scientists do not seek to actively engage in grant activities.

Discussion

There is another type of motivation which is quite close to the value motivation. **Cognitive motivation** includes curiosity, enjoyment of cognitive efforts, the need for actual or theoretical solution to the problem, the focus on obtaining fundamentally new knowledge based on interest, not associated with practical benefits. Of course, it should be the basis of scientific activity, since the ultimate goal of science is to obtain fundamentally new knowledge. The heyday of cognitive motivation falls on the early periods of scientific career and it is important at this point to give it opportunities for development. Unfortunately, modern science management system often destroys cognitive motives. If at a young age cognitive motivation has not been formed and has not become a leader in the structure of scientific activity, then in the subsequent age periods it can no longer occur, respectively, there is no sense to stimulate it, as there is no sense to expect fundamentally new scientific results from these employees. In the process of training young scientists, a huge role is played by the formation of the value-normative base, the formation of ideas that intellectual potential is necessary not to win the grant competition, but to expand the system of socially useful knowledge.

Anti-motivation is the motivation of overcoming, when the stimulating effect is exerted by external (resistance of the material under study, nature) or internal (own psychological characteristics – personality traits, etc.) conditions that complicate the implementation of scientific activities. This subsystem appears not in all the subjects, but even if we are dealing with an employee with a pronounced anti-motivation, it makes no sense to create additional difficulties for him, considering that they activate it. Scientific work in the Russian Federation often consists of overcoming a series of obstacles, therefore, in relation to anti-motivation, efforts should be directed to its reduction.

For effective research the **achievement motivation** must be closely connected with the intrinsic or cognitive motivation. Sometimes, however, in the **achievement motivation** there is a kind of overlap with the external motivation, as a result, the motivation of achievement begins to be focused on obtaining material benefits, status, position. The emergence of such a tendency is provoked, among other things, by the existence of grant system against the background of excessively meager basic wages. To avoid such a tendency, the researcher should also have the opportunity of career advancement, which can be carried out proactively. From this point of view, the system of positions of researchers in the Russian Federation is quite effective, because it can "cover" the period of 24–30 years with its stimulating effect.

Indirect motivation includes the whole set of motives and other entities that can create conditions for the successful implementation of scientific activities, while not being directly related to scientific work. In other words, these are some additional opportunities provided by belonging to the category of researchers and to a particular University or research Institute. As a rule, these are memberships in some interest groups, informal creative associations, etc. They arise spontaneously and reflect the line of interests, or hobbies, which already exist in a significant number of employees (literary newspaper, ski or tourist group etc.). It is important for management to recognize the existence of these communities, as well as their important role and significance. The motivating factor will be if the management will take care of various issues related to the activities of such communities – care of their place of work, material equipment, financing (at least partially), awarding of participants, coverage of the work of communities at official events, for example, at scientific councils, along with other equally important scientific issues.

It is clear that for groups and for individuals the principles and methods of motivation will be different. However, for any group to work effectively, there must be a strong motivation for each individual member. At the same time, the motives of the group members should not enter into confrontation. This requires finding a reasonable balance between individual and group incentives. Individual stimulation should not suffer from the group nature of work and vice versa.

In conclusion, it should be noted that the system of motivation of scientific activity also has a very complex temporal organization. It is almost impossible to get the result immediately after some stimulating action. This is due, first, to the nature of the scientific work, as well as due to the nature of the internal processes taking place in the MSA system itself.

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