The Associations Between Tolerance for Ambiguity and Internal and External Motivation in the Scholarly Activities of Doctoral Students

Nailya R. Salikhova[1], Martin F. Lynch[1,2,3], Albina B. Salikhova[4]

[1] *Kazan Federal University, Kazan, Russia*
E-mail: Nailya.Salihova@kpfu.ru, Tel: +7(843)221-3490
ORCID: https://orcid.org/0000-0003-3937-8978

[2] *University of Rochester, Rochester, New York, USA.*

[3] *National Research University Higher School of Economics, Moscow, Russia*
E-mail: mlynch@warner.rochester.edu;
ORCID: https://orcid.org/0000-0002-5319-3235

[4] *I.M. Sechenov First Moscow State Medical University, Moscow, Russia.*
E-mail: calixalbina@yandex.ru, Tel: +7(843)523-2113
ORCID: https://orcid.org/0000-0001-9449-8329

Abstract
The fluidity, variety and high speed of change of the modern world breed uncertainty and ambiguity. This ambiguity is a consequence of freedom of choice, and the many alternatives with which a person grapples. Ambiguity is both the condition and the subject matter of research activity. The aim of the present study was to clarify the associations of tolerance for ambiguity with the type of motivation (internal or external) for various types of academic activity carried out by doctoral students in a university. Doctoral students ($N = 227$) from natural science departments at Kazan University (Russia) identified their level of ambiguity tolerance (high and low). Results showed a positive link between ambiguity tolerance and external motivation for various forms of university-related activity and an inverse link with internal motivation. Doctoral students with a lower level of ambiguity tolerance showed a higher level of internal motivation for their scholarly activities, that is, avoidance of uncertainty served as a source of internal motivation for research-related activities. For those with high ambiguity tolerance, more external stimuli (reward, constraint) were needed to motivate the person for research. Moreover, at high levels of ambiguity tolerance the direction of the associations changed and becomes a positive link between internal motivation and ambiguity tolerance. The results should be taken into account in the organization of higher education.
Keywords: tolerance for ambiguity, doctoral students, internal motivation, academic-scholarly activity, education, self-determination.

Взаимосвязь внутренней и внешней мотивации деятельности аспирантов университета с толерантностью личности к неопределенности

Наиля Р. Салихова[1], Мартин Ф. Линч[1,2,3], Альбина Б. Салихова[4]

[1] *Казанский федеральный университет, Казань, Россия*
E-mail: Nailya.Salihova@kpfu.ru
ORCID: https://orcid.org/0000-0003-3937-8978

[2] *Рочестерский университет, Рочестер, шт. Нью-Йорк, США*

[3] *Национальный исследовательский университет «Высшая школа экономики»,*
Москва, Россия
E-mail: mlynch@warner.rochester.edu
ORCID: https://orcid.org/0000-0002-5319-3235

[4] *Первый Московский государственный медицинский университет имени И.М. Сеченова,*
Москва, Россия.
E-mail: calixalbina@yandex.ru
ORCID: https://orcid.org/0000-0001-9449-8329

Аннотация
Изменчивость, разнообразие и высокая скорость эволюции современного мира порождают неопределенность. Эта неопределенность является следствием свободы выбора и множества альтернатив, с которыми сталкивается человек. В исследовательской деятельности неопределенность является ее постоянным условием и даже предметом. Целью этого исследования стало выявление взаимосвязи толерантности к неопределенности с типом (внутренняя или внешняя) мотивации в различных видах академической деятельности в аспирантуре. У аспирантов ($N = 227$) естественно-научных специальностей Казанского университета (Россия) был определен уровень толерантности к неопределенности (высокий и низкий). Результаты выявили прямую связь толерантности к неопределенности с внешней мотивацией и обратную связь с внутренней мотивацией деятельности аспирантов в университете. Это значит, что при низком уровне толерантности к неопределенности аспиранты имеют более высокий уровень внутренней мотивации научной деятельности, то есть избегание неопределенности служит источником её внутренней мотивации. При высокой толерантности к неопределенности аспирантам требуется больше внешних стимулов (вознаграждений, ограничений) для мотивации исследовательской деятельности. Однако в группе с высоким уровнем толерантности к неопределенности направление связей меняется: связь внутренней мотивации с толерантностью к неопределенности становится прямой. Результаты могут быть использованы в практике организации высшего образования.
Ключевые слова: толерантность к неопределенности, аспиранты, внутренняя мотивация, академическая деятельность, образование, самоопределение.

Introduction

The modern world is considered to be in an age of growing uncertainty, complexity, and diversity (Asmolov, 2015; Leontiev, 2018; Taleb, 2012), in which there are contradictory tendencies of fluidity and stability. The transitory condition of society, by strengthening uncertainty and variability, poses a challenge to the individual (Martsinkovskaya 2018), demanding not so much a strategy of adaptation as of pre-adaptation to the world (Asmolov, 2015). This points to the need not only to come to terms with complexity, uncertainty, and ambiguity, but to utilize them to one's advantage.

The organization of the third stage of higher education, the reform of which was recently realized in the Russian Federation, should provide for the preparation of future teachers in higher education (teachers for teachers), who are capable of effectively acting in the circumstances of the modern world with all of its challenges. Preparation of faculty with higher research qualifications implies not only acquisition by means of activity, but also personal development as a researcher. Accordingly, it is necessary to consider the personal characteristics of the person when creating the most effective conditions for their development in the context of the university. One of the most important characteristics in the modern world is the ability to live and to act under circumstances of uncertainty or ambiguity.

Ambiguity represents not only difficulty, but also possibilities for freedom of choice by virtue of the variety of alternatives with which the person is faced. In making a choice, a person converts ambiguity, uncertainty and chaos into something orderly, creating for themselves the possibility of acting in this ambiguous world. As D. A. Leontiev (2015) writes, the limitation of uncertainty, of ambiguity, is the necessity and condition of the person's acting as a self-determined subject. Self-determination theory (Ryan & Deci, 2017) emphasizes the importance of the person's internal motivation in the regulation of one's own life and activity. One might expect that when a person is internally motivated and has their own criteria for activity, that person can be more effective in ambiguous situations, creating their own supports and islands of certainty in a constantly changing and uncertain world. This needs to be taken into account in the preparation of the future university researcher and teacher.

Problem statement

According to a number of scholars (e.g., Asmolov, 2015; Zinchenko, 2007; McLain, 1993; Sokolova, 2015), ways of reacting to ambiguity depend upon one's relationship to it. Ambiguity can be frightening, if one considers it abnormal, but if one considers it to be an important resource for increasing the degree of one's freedom, then ambiguity becomes a necessary condition for the self-development of the person (Leontiev, 2015; Taleb, 2012).

The concept of ambiguity tolerance arose in order to clarify and describe various types of relationship to ambiguity. McLain (1993) considered ambiguity tolerance "a range, from rejection to attraction, of reactions to stimuli perceived as unfamiliar, complex, dynamically uncertain, or subject to multiple conflicting interpretations" (p. 185). In the scale he created to measure tolerance for ambiguity, besides indicators of one's own acceptance or avoidance of ambiguity, are also included subscales which define the person's relationship toward novelty and complexity.

Understanding the role of ambiguity tolerance in conjunction with both its determinants and its consequences is especially relevant for those types of activity in which ambiguity is a constant condition and even a subject matter, and for research activity in particular. It is possible that for the researcher, a less common type of reaction to ambiguity is characteristic, which Sokolova (2015) described as joy and passion from the process of research, as insight, curiosity and pleasure in the construction of new meanings. In our view, such effects can arise under conditions in which a person's activity is supported by internal motivation.

In motivational psychology, a distinction is traditionally made between internal and external motivation in a person's actions (Heckhausen & Heckhausen, 2009; Ryan & Deci, 2017). Internal motivation is defined as the free engagement and participation of the person in an activity under one's own initiative, on the basis of one's own choice; although external demands or reinforcers may be present, they are not salient to the internally motivated person. External motivation is linked with the necessity felt to

participate in an activity on the basis of obligation, force or the pressure of external circumstances, for the sake of attainment of goals which are external to the activity itself. According to self-determination theory, at the base of internal motivation lies one of the basic psychological needs – the need for autonomy. This is the inherent tendency of the person to feel oneself the initiator of one's own actions, to internally regulate one's own behavior. Numerous studies have demonstrated that satisfaction of the basic psychological needs -- for autonomy, competence, and relatedness (Ryan & Deci, 2017) -- serves as the necessary condition for psychological well-being (Chirkov, Vansteenkiste, Tao, & Lynch, 2007). Researchers have also devoted considerable attention to the various effects of external and internal motivation, and their interrelations with various other psychological phenomena (Deci & Ryan, 2007; Ryan & Deci, 2017). Thus for example, the importance of internal motivation for the effectiveness of activity in various forms has been demonstrated, among them educational (Vansteenkiste, Lens, & Deci, 2006; Ryan & Lynch, 2003). While satisfying the need for autonomy, the person reveals his or her potential, develops more fully and more effectively interacts with the environment. It is possible to suppose that when a person is internally motivated and has their own criteria for their own activity, then that person can be more effective in situations of ambiguity, themselves creating the supports and islands of certainty in a constantly changing and uncertain world.

The fundamental basis for conscious choice is a personal system of values and meanings, and, accordingly, the primary tool for overcoming ambiguity is meaning (Zinchenko, 2007; Salikhova, 2009, 2015). When a person is internally motivated, he or she acts on the basis of their values and meanings, which create for the person an internal support for overcoming the ambiguity of the world and the creation of one's own island of certainly in that world. There is some empirical evidence for this claim. The research of Leontiev (2015) has shown that students with a high level of meaningfulness in life and future orientation displayed orienting-exploratory behavior in ambiguous situations, and Osin (2010) has found correlations between ambiguity tolerance and level of meaningfulness in life, also on a student sample.

All of the above provides the basis to suggest that motivation for various types of academic activity among doctoral students might depend on the person's level of tolerance for ambiguity.

In analyzing the components of the academic activity of doctoral students at the higher levels of education, directed toward the preparation of the researcher, we distinguish two psychologically distinct types of such activity. On the one hand, in the preparation of a researcher are included types of activity that are immediately linked to the activity that is directed toward the object of the research: the gathering and analysis of the scientific literature on the topic, the organization of the research and collection of material, and also its analysis and generalization in the form of a scientific text. On the other hand, the program for such preparation includes types of activity that are linked with communication in the scientific community: communicating with one's supervisor or adviser, laboratory colleagues or research group, participation in group lessons. Each of these types of activity is connected with situations that create one's qualitatively distinctive challenges in ambiguity.

Objective of the research

The focus of the present study is the type of motivation, internal or external, that predominates in the various types of activity of doctoral students in the context of the university and how that is associated with the person's level of ambiguity tolerance, that is, the ability to cope with these challenges of the contemporary world. We suggest that

ambiguity tolerance is linked with internal motivation for the various types of academic activity in which doctoral students engage at the higher levels of education. In this regard, depending on the type of such activity – directed toward the topic of the research or to communication within the scientific community – the significance of ambiguity tolerance for internal motivation might vary. Investigation of these assumptions was the aim of the study.

Methods

Data collection methods

The following measures were administered.

The Russian language version of the Multiple Stimulus Types Ambiguity Tolerance (MSTAT-1; McLain, 1997), adapted into Russian (Leontiev, Osin, & Lukovitskaya, 2016). The items of the questionnaire form three scales based on the presumed source of the ambiguity, assessing attitudes toward novelty (N), complex tasks (CT), and situations of ambiguity (SA), and two scales based on the modality of attitudes to sources of ambiguity, preference for ambiguity (PA) (all positively worded items in the questionnaire) and avoidance of ambiguity (AA) (all negatively worded items in the questionnaire). High scores on the last scale indicate a person's tendency not to look for opportunities to avoid uncertainty (rather than the opposite, that is, the desire to avoid it). There is also a general tolerance for ambiguity (TA) measure. Cronbach alphas in the present sample were 0.72 (N), 0.76 (CT), 0.81 (SA), 0.83 (PA), 0.82 (AA), and 0.88 (TA).

Self-Regulation for Learning (SRQ-L; Black & Deci, 2000). We adapted five items from this scale to reflect the degree to which doctoral students acted with internal or autonomous motivation for their university-based activities. Specifically, three items tapped internal reasons ($\alpha = .92$), and two items tapped external reasons ($\alpha = .88$). Items were scored on a scale of 1 to 5, with higher scores reflecting more internal or more external motivation, respectively. The activities for which participants needed to rate their motivation included: "I write a scholarly text (thesis, article, etc.)," "I organize and collect data for research," "I search for and synthesize information about a research topic," "I attend a class at the university," "I discuss work with my scientific director/research advisor," "I discuss work with my colleagues / classmates." Separate composite scores were computed for internal motivation and external motivation by averaging across all six of the university-based activities. As well, we computed a relative autonomy index (RAI) by subtracting external from internal scores.

Description of the survey sample

The current study surveyed 229 doctoral students enrolled at Kazan Federal University (Kazan, Republic of Tatarstan, Russian Federation), among them 116 men and 113 women ranging in age from 22 to 37 years ($median_{age}=24$, $M_{age}=24.4$, $SD_{age}=1.9$). Participation was voluntary, with no compensation, and anonymity was guaranteed.

Data processing methods

At the first step of analysis, descriptive statistics and Pearson's correlations were computed for the full sample.

At the second step of analysis the data were divided into two contrasting groups using as the criterion the level of tolerance for ambiguity: one group with the highest indicator (1st quartile) of TA (general tolerance for ambiguity) and the group with the lowest indicator (4th quartile) of TA. Both groups consisted of 57 people. Groups were compared using independent two-sample Student t-test. Pearson's correlations were then computed for the contrasting groups.

Results

The correlations of individual's tolerance to uncertainty with internal and external motivation and their discrepancy in various forms of university-related activity

Looking at the full sample ($N = 229$), the correlations of individual's tolerance to uncertainty with internal and external motivation and their discrepancy[1] in various forms of university-related activity are presented in the table 1.

Table 1. **Pearson correlations of individual's ambiguity tolerance with indicators of internal motivation (IM) and external motivation (EM) and their relative autonomy index (RAI) in various forms of university-related activity, sample-wide.**

University activities		MSTAT Questionnaire's scales											
		N		CT		SA		PA		AA		TA	
		r	p	R	p	r	p	r	p	r	P	r	p
I write a scholarly text (thesis, article, etc.)	IM	-0.07	0.281	-0.09	0.157	**-0.18**	**0.005**	-0.06	0.349	**-0.24**	**0.000**	**-0.16**	**0.013**
	EM	0.17	0.009	0.21	0.002	0.16	0.016	0.17	0.008	0.24	0.000	0.21	0.001
	RAI	-0.15	0.019	-0.19	0.004	-0.22	0.001	-0.15	0.023	-0.31	0.000	-0.24	0.000
I organize and collect data for research	IM	-0.04	0.498	-0.10	0.130	**-0.15**	**0.025**	-0.04	0.538	**-0.21**	**0.001**	**-0.14**	**0.031**
	EM	**0.14**	**0.039**	**0.19**	**0.003**	0.07	0.321	0.16	0.012	0.15	0.026	0.18	0.006
	RAI	-0.11	0.089	**-0.18**	**0.005**	**-0.14**	**0.032**	-0.13	0.055	**-0.23**	**0.000**	**-0.21**	**0.002**
I search for and synthesize information about a research topic	IM	**-0.14**	**0.037**	**-0.16**	**0.017**	**-0.14**	**0.029**	-0.11	0.082	**-0.24**	**0.000**	**-0.19**	**0.003**
	EM	0.19	0.004	0.17	0.010	0.13	0.047	0.17	0.008	0.19	0.003	0.22	0.001
	RAI	-0.20	0.002	-0.21	0.002	-0.17	0.008	-0.18	0.006	-0.27	0.000	-0.26	0.000
I attend a class at the university	IM	-0.05	0.409	-0.09	0.185	-0.10	0.120	-0.09	0.176	**-0.14**	**0.030**	-0.13	0.057
	EM	**0.17**	**0.011**	0.13	0.054	**0.16**	**0.013**	**0.16**	**0.013**	**0.18**	**0.007**	**0.23**	**0.001**
	RAI	-0.14	0.029	-0.14	0.033	-0.17	0.008	-0.16	0.013	-0.21	0.001	-0.23	0.000
I discuss work with my research advisor	IM	-0.07	0.294	-0.12	0.066	-0.08	0.224	-0.09	0.194	**-0.14**	**0.036**	-0.12	0.067
	EM	**0.17**	**0.008**	**0.17**	**0.011**	0.11	0.099	**0.14**	**0.036**	**0.19**	**0.004**	**0.16**	**0.015**
	RAI	-0.16	0.015	**-0.19**	**0.003**	-0.13	0.056	**-0.15**	**0.024**	**-0.22**	**0.001**	**-0.19**	**0.004**
I discuss work with my colleagues / classmates	IM	0.05	0.480	-0.02	0.762	0.08	0.254	0.03	0.676	0.00	0.999	0.00	0.941
	EM	0.17	0.011	0.19	0.004	0.14	0.033	0.17	0.009	0.18	0.006	0.17	0.011
	RAI	-0.09	0.154	**-0.17**	**0.012**	-0.05	0.446	-0.11	0.086	**-0.14**	**0.030**	**-0.13**	0.050

Legend: r = correlation coefficient, p = significance level. Bold type indicates significant results.

The general indicator, tolerance for ambiguity (TA), demonstrated the largest number of correlations with external, internal, and relative autonomy (15 out of 18 possible). External motivation in various situations of doctoral students' academic activity was associated positively with tolerance for ambiguity, but negatively with internal motivation and with the relative autonomy index. External motivation for all types of academic activity was significantly and positively associated not only with general tolerance for ambiguity (six out of six possible), but also with such aspects as preference for (PA) and absence of avoidance of (AA) ambiguity, attitude toward novelty (N) and to complex tasks (CT) (35 out of 36 possible correlations), and slightly less univocally with attitudes toward ambiguous situations (SA; four out of six possible correlations).

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[1] As noted, the discrepancy between internal and external motivation was used to compute a 'relative autonomy index' for each participant.

Internal motivation demonstrated a link with elements of ambiguity tolerance much less frequently (13 out of 36 possible correlations), and all of the identified associations were negative. The largest number of such links with internal motivation were related to the situation, "I search for and synthesize information about a research topic" (five out of six possible correlations) and to the aspect of absence of ambiguity avoidance (five of six correlations). There were somewhat fewer significant links between internal motivation and aspects of ambiguity tolerance in the situations, "I write a scholarly text" (three of six possible) and "I write a scholarly text" (three of six). The index of relative autonomy (RAI) had significant inverse associations with all aspects of ambiguity tolerance in almost all situations of doctoral students' research activity (30 out of 36 possible correlations).

Results of the comparison of internal and external motivation and their discrepancy in various forms of university-related activity by contrast groups (with respect to level of individual's ambiguity tolerance)

Results of comparison are shown in Table 2.

Table 2. **Indicators of internal (IM) and external motivation (EM) and their discrepancy (RAI) in various forms of university-related activity and their comparison by Student's t-test in contrast groups.**

Group Parameter		Low MSTAT n=41		High MSTAT n=19		t – fact	Significance of the difference
		Ā	σ	ā	σ		
I write a scholarly text (thesis, article, etc.)	IM	10.53	2.19	9.26	2.14	**3.11**	**0.002**
	EM	6.98	1.70	8.18	1.82	-3.62	0.000
	RAI	3.54	3.24	1.09	3.03	**4.18**	**0.000**
I organize and collect data for research	IM	9.91	1.93	8.93	1.94	**2.71**	**0.008**
	EM	7.46	1.74	8.14	1.78	**-2.08**	**0.040**
	RAI	2.46	3.01	0.79	2.81	**3.06**	**0.003**
I search for and synthesize information about a research topic	IM	9.86	2.00	8.60	2.10	3.28	0.001
	EM	7.54	1.97	8.47	1.77	**-2.65**	**0.009**
	RAI	2.32	3.11	0.12	3.16	**3.73**	**0.000**
I attend a class at the university	IM	9.67	1.79	8.77	2.24	**2.36**	**0.020**
	EM	7.12	1.89	7.93	1.97	**-2.23**	**0.028**
	RAI	2.54	3.01	0.84	3.10	2.97	0.004
I discuss work with my research advisor	IM	9.72	1.99	8.86	2.08	**2.25**	**0.026**
	EM	7.70	2.04	8.63	1.77	**-2.60**	**0.010**
	RAI	2.02	3.10	0.23	3.02	**3.12**	**0.002**
I discuss work with my colleagues / classmates	IM	7.68	1.93	7.61	2.08	0.19	0.852
	EM	7.46	2.24	8.37	1.79	**-2.40**	0.018
	RAI	0.23	2.54	-0.75	2.41	**2.12**	0.036

Legend: ā = average, σ = dispersion. Bold type is used to indicate significant results.

Comparison of the groups of doctoral students who were high and those who were low in ambiguity tolerance with respect to external motivation for academic, scholarly activity demonstrated significant differences for all surveyed situations such that external motivation predominated among doctoral students with high ambiguity tolerance in comparison with those low in tolerance. Among doctoral students with low ambiguity

tolerance internal motivation was significantly higher in almost all situations of academic, scholarly activity with the exception of the situation of discussion, "I discuss work with my work with colleagues/classmates". Among doctoral students with low ambiguity tolerance the index of autonomous motivation (RAI) was also higher with respect to their research activities, and this difference was statistically significant for all types of academic activity.

The correlations of individual's ambiguity tolerance with internal and external motivation and their discrepancy in various forms of university-related activity: comparison of contrast groups

Results of Pearson correlations of individuals' tolerance for ambiguity (MSTAT) with indicators of internal motivation (IM) and external motivation (EM) and their 'relative autonomy index' discrepancy (RAI) in various forms of university-related activity are shown in Table 3 for the low MSTAT group and in Table 4 for the high MSTAT group.

Table 3. **Pearson correlations of individual's ambiguity tolerance (MSTAT) with indicators of internal motivation (IM) and external motivation (EM) and their relative autonomy index (RAI) in various forms of university-related activity (low MSTAT group).**

University activities		MSTAT Questionnaire's scales											
		N		CT		SA		PA		AA		TA	
		r	p	r	p	r	p	r	p	r	p	r	p
I write a scholarly text (thesis, article, etc.)	IM	-0.09	0.495	0.07	0.589	-0.11	0.398	0.07	0.596	-0.17	0.200	0.03	0.828
	EM	0.21	0.124	-0.14	0.295	-0.07	0.583	-0.02	0.871	-0.06	0.679	-0.12	0.364
	RAI	-0.17	0.205	0.12	0.361	-0.04	0.778	0.06	0.657	-0.09	0.518	0.08	0.534
I organize and collect data for research	IM	-0.12	0.371	0.01	0.934	-0.10	0.467	0.07	0.595	-0.20	0.141	-0.01	0.919
	EM	0.12	0.373	-0.03	0.827	0.09	0.526	0.14	0.303	0.01	0.956	0.20	0.143
	RAI	-0.15	0.274	0.02	0.857	-0.11	0.404	-0.03	0.800	-0.13	0.331	-0.12	0.363
I search for and synthesize information about a research topic	IM	-0.18	0.185	-0.02	0.893	-0.05	0.718	0.10	0.446	**-0.29**	**0.030**	-0.05	0.693
	EM	0.14	0.307	-0.10	0.458	0.06	0.657	0.15	0.255	-0.10	0.443	0.20	0.144
	RAI	-0.20	0.132	0.05	0.701	-0.07	0.607	-0.03	0.819	-0.12	0.377	-0.16	0.238
I attend a class at the university	IM	-0.13	0.333	0.01	0.919	-0.15	0.263	0.06	0.665	**-0.27**	**0.040**	-0.08	0.556
	EM	-0.04	0.762	-0.16	0.244	0.08	0.534	0.01	0.942	-0.06	0.654	**0.31**	**0.019**
	RAI	-0.05	0.703	0.11	0.429	-0.14	0.290	0.03	0.833	-0.12	0.359	-0.24	0.070
I discuss work with my research advisor	IM	0.02	0.908	0.03	0.814	0.00	0.982	0.09	0.505	-0.09	0.485	0.05	0.736
	EM	0.24	0.067	-0.01	0.965	0.08	0.563	0.16	0.236	0.00	0.997	-0.04	0.758
	RAI	-0.15	0.264	0.02	0.857	-0.05	0.715	-0.05	0.729	-0.06	0.656	0.06	0.675
I discuss work with my collea-gues / classmates	IM	0.14	0.282	-0.13	0.349	0.13	0.344	0.09	0.521	-0.03	0.828	-0.05	0.719
	EM	0.16	0.235	0.01	0.951	0.04	0.793	0.09	0.516	0.01	0.958	-0.08	0.538
	RAI	-0.03	0.822	-0.10	0.446	0.07	0.629	-0.01	0.933	-0.03	0.832	0.04	0.788

Legend: r = correlation coefficient, p = significance level. Bold type indicates significant results.

Analysis of the interrelations among internal motivation, external motivation, and the index of relative autonomy with aspects of ambiguity tolerance demonstrated an unremarkable number of these in the group of doctoral students with low ambiguity tolerance. The variables and direction of the associations repeated those found in the full sample; however, their extremely small proportion within the overall picture of non-significant associations does not allow them to be considered seriously.

Table 4. **Pearson correlations of individuals' ambiguity tolerance (MSTAT) with indicators of internal motivation (IM) and external motivation (EM) and their relative autonomy index (RAI) in various forms of university-related activity (high MSTAT group).**

University activities		MSTAT Questionnaire's scales											
		N		CT		SA		PA		AA		TA	
		r	p	r	p	r	p	r	p	r	p	r	p
I write a scholarly text (thesis, article, etc.)	IM	0.03	0.825	**0.29**	**0.031**	**0.37**	**0.005**	**0.39**	**0.003**	0.14	0.291	**0.33**	**0.011**
	EM	0.24	0.073	**0.27**	**0.046**	-0.05	0.719	0.18	0.181	0.15	0.253	0.20	0.127
	RAI	-0.12	0.362	0.04	0.752	**0.29**	**0.030**	0.17	0.208	0.01	0.953	0.11	0.406
I organize and collect data for research	IM	0.13	0.331	0.25	0.056	**0.32**	**0.016**	**0.38**	**0.004**	0.19	0.157	**0.35**	**0.008**
	EM	0.09	0.524	**0.31**	**0.017**	-0.25	0.065	0.02	0.885	0.12	0.387	0.08	0.550
	RAI	0.04	0.792	-0.02	0.864	**0.38**	**0.004**	0.25	0.066	0.06	0.675	0.19	0.159
I search for and synthesize information about a research topic	IM	0.12	0.394	0.16	0.231	**0.41**	**0.002**	**0.34**	**0.009**	0.16	0.228	**0.31**	**0.018**
	EM	0.14	0.283	0.26	0.055	-0.20	0.144	0.04	0.774	0.12	0.386	0.09	0.490
	RAI	0.00	0.973	-0.04	0.789	**0.38**	**0.003**	0.21	0.125	0.04	0.755	0.16	0.249
I attend a class at the university	IM	-0.03	0.839	0.05	0.695	**0.39**	**0.003**	0.10	0.451	0.18	0.171	0.17	0.200
	EM	0.25	0.060	**0.27**	**0.044**	0.33	0.012	0.28	0.035	0.37	0.004	0.40	0.002
	RAI	-0.18	0.182	-0.13	0.329	0.07	0.609	-0.10	0.441	-0.10	0.444	-0.13	0.348
I discuss work with my research advisor	IM	0.03	0.818	0.01	0.936	**0.29**	**0.031**	0.23	0.089	0.03	0.821	0.16	0.227
	EM	0.23	0.086	0.14	0.293	-0.19	0.146	0.00	0.997	0.11	0.406	0.07	0.626
	RAI	-0.11	0.405	-0.08	0.577	**0.31**	**0.018**	0.16	0.245	-0.04	0.743	0.07	0.587
I discuss work with my colleagues / classmates	IM	0.24	0.074	0.15	0.279	0.23	0.085	**0.29**	**0.027**	0.08	0.561	0.23	0.082
	EM	0.23	0.086	0.11	0.405	-0.19	0.160	0.02	0.884	0.03	0.804	0.03	0.812
	RAI	0.04	0.792	0.04	0.755	**0.34**	**0.010**	0.24	0.074	0.04	0.751	0.18	0.188

Legend: r = correlation coefficient, p = significance level. Bold type indicates significant results.

In the group of doctoral students with high ambiguity tolerance, as in the overall sample, ambiguity tolerance was positively associated with external motivation for research activity; however, those associations were much fewer, and they were limited to only one type of situation of research activity and one aspect of aspect of ambiguity tolerance. Thus, the higher the ambiguity tolerance in the range of its values, the more external motivation was expressed for the situation, "I attend a class at the university," and the more positive the attitude toward complex tasks (CT), the more external motivation was expressed in the fulfilment of one's research activity. In this group a substantial number of associations between the index of relative autonomy and ambiguity tolerance was revealed, which distinguishes this group from the group with low ambiguity tolerance.

Genuinely unexpected, however, in light of the findings previously described, was that the direction of association between both internal motivation and the relative autonomy index with various aspects of ambiguity tolerance was opposite that which was obtained across the full range of ambiguity tolerance. An elevated level of internal motivation for research activity was linked with greater preference for ambiguity (PA) and with a more positive attitude toward situations of ambiguity (SA) in this group of doctoral students. Moreover, these associations for the most part were with respect to those types of research activity which are directly directed toward the subject of the research, rather than situations of discussing the research. With regard to the index of autonomous motivation (RAI) for research activity, it was also higher for doctoral students with high ambiguity tolerance when attitudes toward ambiguous situations (SA) were more positive.

Discussion

The results obtained in the overall sample on the one hand supported our hypothesis: tolerance for ambiguity (TA) and most of its components were significantly associated with motivation for the various types and stages of doctoral students' research activity. However, the direction of the associations was opposite of what we predicted. It turned out that the internal motivation of university doctoral students for academic activity was on the whole not so strongly associated with ambiguity tolerance. By contrast, external motivation was directly associated with ambiguity tolerance in various types and stages of academic activity. The index of autonomous motivation (RAI) occupied an intermediate position, and, as with internal motivation, the associations with ambiguity tolerance were inverse.

These seemingly paradoxical results are consistent with what we have previously found (Salikhova, Lynch & Salikhova, 2018), specifically, that internal motivation for doctoral students' academic activity was characteristic for those who have low levels of meaningfulness in life. In other words, the results of two studies bear witness to the fact that everything associated with the form of the effective, successful, and sustainable person with respect to the challenges of the contemporary world (a high level of meaningfulness in life, tolerance for ambiguity) in the academic activity of the doctoral student is linked with the external character of her motivation, which is to say with the expectation of rewards or other coercive measures. Both low ambiguity tolerance and low meaningfulness in life generate internal motivation in doctoral students' academic activity, which can be interpreted as compensatory, that is, as a striving through one's research to overcome ambiguity and to create certainty, as also to overcome low meaningfulness in life and, perhaps, through or in the very scientific search to find meaning.

A more detailed scrutiny by means of the contrast groups found that external motivation for all stages and types of research activity was more significant among doctoral students with high ambiguity tolerance. This means that coercion or rewards, or some other external parameters became for them the source of motivation in their university academic activity. Moreover, internal motivation for academic activity was greater among doctoral students with low tolerance for ambiguity. These results agree with what had already been found through correlation analysis.

It is interesting to compare the links of motivation for the two types of academic activity (subject-related and communicative) with tolerance for ambiguity. Ambiguity tolerance among doctoral students for the most part was linked with internal motivation for those types of academic activities which are immediately directed to the subject or topic of research: the search for information in the scientific literature about the subject being studied, data collection, data analysis and synthesis, including the writing of scientific texts. At the same time, there were no links whatsoever between internal motivation and communicative situations with the exception of discussion of one's work with one's research advisor. It is possible to say that internal motivation was characteristic for those types of activity which for the most part were linked with the creation of certainty out of uncertainty or ambiguity. It is likely that it is precisely the impossibility of tolerating ambiguity and the striving to overcome ambiguity, to arrive at some kind of certainty, which is evoked by the absence of ambiguity tolerance (TA), and becomes a source of internal motivation, a source of internal prompting toward the research activity as a means to moving from a state of ambiguity to one of certainty. This means that low ambiguity tolerance can be considered a source of internal motivation in certain types of academic activity among doctoral students.

Even more interesting, in the group with high ambiguity tolerance, there appeared a different pattern and an opposite type of association: the higher the TA, the higher

the internal motivation for research. It is likely that this was a different type of internal motivation, which might be associated with the striving to move toward something new and unknown, to broaden one's horizons, perhaps, increasing the risk of falling into a situation of ambiguity. We underscore that these associations were found only under high levels of ambiguity tolerance. The majority of associations of internal motivation with ambiguity tolerance in the group with high tolerance was similarly related to types of academic activity that were subject-directed, that is, to the research situations, "I write a scholarly text (thesis, article, etc.)," "I organize and collect data for research," and "I search for and synthesize information about a research topic," whereas external motivation was directly linked with TA only in the situation, "I attend a class at the university."

Also interesting were the various aspects of ambiguity tolerance with which various associations arose. In the overall sample the parameter most strongly linked with external motivation was ambiguity avoidance (AA), that is, the greater the avoidance, the greater the significance of external motivation in all types of academic activity among doctoral students. In the group of highly tolerant doctoral students, different parameters of ambiguity tolerance came to the fore: specifically, preference for ambiguity (PA) and a more positive attitude toward it (SA). In the majority of cases they were directly (i.e., positively) linked with internal motivation, whereas there were almost no associations with ambiguity avoidance in this group.

Thus, through the construct, ambiguity tolerance, it was possible to distinguish *two different sources of internal motivation* in the academic activity of doctoral students: firstly, low tolerance for ambiguity, which begets an internally motivated striving toward certainty; and secondly, high tolerance for ambiguity as a striving toward broadening the horizons of ambiguity, of uncertainty, which appears only in the range of high levels of ambiguity tolerance.

Conclusion

Generalizing the results, we can suggest:

1. Tolerance for ambiguity is more strongly associated with external motivation in the academic activity of doctoral students, and these associations are positive: for doctoral students who are high rather than low in ambiguity tolerance, external incentives are necessary.

2. Internal motivation for doctoral students' academic activity is associated, to a lesser extent than external motivation, with the level of ambiguity tolerance; indeed, the associations that were found were inverse, that is, *intolerance* for ambiguity serves as a source of internal motivation for academic activity.

3. More strongly linked with ambiguity tolerance was internal motivation for subject-oriented types of research activity among doctoral students, compared with the communicative components of academic activity.

4. Under high levels of ambiguity tolerance, internal motivation was positively linked with ambiguity tolerance, which permits us to speak of a new quality of research activity, which is promoted by the striving toward broadening the horizons of ambiguity.

Applications

The results raise questions about the specifics of the current higher level of education in Russia, and also, perhaps, about the specifics of scientific activity in contemporary science. Scientific activity to a large degree is becoming similar to an assembly line production of knowledge among the members of large research groups in which responsibilities are distributed, which means, for the various components of this activity

for the individual scientist, it most likely creates for him or her situations of certainty rather than uncertainty or ambiguity.

Limitations

Of course, the generalizability of the associations found in the present study remains an open question. It is possible that they might be different depending on the age or the level of experience of the researcher, or on the qualifications and nature of the particular research group. In addition, the question of the direction of association of internal and external motivation among doctoral students for their academic activities with the person's attitude toward ambiguity remains a matter of interpretation.

Acknowledgments

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