

# PSYCHOLOGY IN RUSSIA: STATE OF THE ART

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## Editorial

The current issue of “Psychology in Russia: State of the Art” provides the special section Mathematical learning: New perspectives and challenges, edited by Marina Vasilyeva, associate professor at Lynch School of Education, Boston College (USA).

Marina A. Kholodnaya and Emanuila G. Gelfman described the experience of using development-focused educational texts (DET technology) as a basis for learners’ intellectual development in studying mathematics. Yulia Solovieva, Yolanda Rosas-Rivera and Luis Quintanar-Rojas provided case-studies of problem solution as a guided activity with Mexican schoolchildren. Marina Vasilyeva, Elida Laski, Aleksandr N. Veraksa and Chen Shen traced the process of development of children’s early understanding of numeric structure.

Interestingly, several articles on mathematical learning are focused on students’ personal traits and attitudes towards mathematics. Marina S. Egorova and Yulia D. Chertkova investigated sex differences in mathematical achievement, basing on grades, national test, and students’ self-confidence. Chen Shen, David B. Miele and Marina Vasilyeva studied the relation between college students’ academic mindsets and their persistence during math problem solving.

Another part of this issue deals with research in developmental and educational psychology. The “Developmental psychology” section suggests papers on development at various ages with focus on adversity, resilience and copings in familial and institutional contexts. Rifkat J. Muhamedrahimov with the colleagues from the St. Petersburg–USA Orphanage Research Team compared pre- and post-intervention structural characteristics of the institutional environment for young children under the state care. Mikhail Yu. Kuzmin and Igor A. Konopak figured out distinctive features of adolescent hardiness in families of different composition — namely, in single-parent, two-parent and large extended families. Maria V. Bogdanova, Irina A. Rusyayeva and Anastasia O. Vylegzhanina investigated gender and age aspects of child psychological defenses in child-mother relationships. Anna G. Samokhvalova and Tatyana L. Kryukova studied communication difficulties in teenagers with health impairments. Elvira E. Symanyuk and Anna A. Pecherkina proposed a model of psychological predictors of inhibition development in educational envi-

ronments. “Inhibition” here is a problematic concept, the opposite of “facilitation” in educational process: deterioration of teacher-children interactions; negation of a student’s individuality and inability to understand and accept students’ viewpoints.

The topic of risk and promoting factors in development is further elaborated in the “Educational Psychology” section. Natalia S. Denisenkova and Anastasia K. Nisskaya investigated the role of teacher-child interaction in promoting peer communication in preprimary students. Focusing on positive outcomes, Olesya Yu. Gorchakova, Valeria V. Matsuta and Sergey A. Bogomaz outlined intellectual and personality factors in the achievement of high exam effectiveness in first-year Russian university students. The article by Irina A. Baeva, Yury P. Zinchenko and Vladimir V. Lapteva deals with psychological resources of modern Russian adolescents’ resilience to violence in the educational environment. Similar issues are discussed in the article by Tatyana I. Kulikova that presents a pilot research on a pupil’s psychological safety in the multicultural educational environment. Finally, Aleksander I. Dontsov and Elena B. Pereyagina performed psychosemantic study of cognitive and value parameters of students’ perceptions of the effects of psychoactive substances with some elaborations on drug abuse prevention.

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## Special section MATHEMATICAL LEARNING: NEW PERSPECTIVES AND CHALLENGES

### **Sex differences in mathematical achievement: Grades, national test, and self-confidence**

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Academic achievement, which is inherently an indicator of progress in the curriculum, can also be viewed as an indirect measure of cognitive development, social adaptation, and motivational climate characteristics. In addition to its direct application, academic achievement is used as a mediating factor in the study of various phenomena, from the etiology of learning disabilities to social inequality. Analysis of sex differences in mathematical achievement is considered particularly important for exploring academic achievement, since creating an adequate educational environment with equal opportunities for boys and girls serves as a prerequisite for improving the overall mathematical and technical literacy that is crucial for modern society, creates balanced professional opportunities, and destroys traditional stereotypes about the roles of men and women in society.

The objective of our research was to analyze sex differences in mathematical achievement among high school students and to compare various methods for diagnosing academic performance, such as school grades, test scores, and self-concept.

The results were obtained through two population studies whose samples are representative of the Russian population in the relevant age group. Study 1 looked at sex differences in math grades among twins ( $n = 1,234$  pairs) and singletons ( $n = 2,227$ ) attending high school. The sample of Study 2 comprised all twins who took the Unified State Examination in 2010–2012. The research analyzed sex differences in USE math scores across the entire sample and within the extreme subgroups. It also explored differences between boys and girls in opposite-sex dizygotic (DZ) twin pairs.

The key results were as follows. No difference in mathematical achievement was observed between twins and singletons. Sex differences were found in all measures of mathematical achievement. Girls had higher school grades in math than boys, while boys outperformed girls in USE math scores. Boys were more variable and there were more

boys at the right tail of the distribution. Girls with a positive math self-concept did better than boys on math tests. In groups of opposite-sex DZ twins, differences between the USE math scores of girls and boys were not significant.

The results obtained are presumed to correspond more closely to assumptions about the roles of non-cognitive factors of variation in mathematical ability than the mathematical ability theory.

**Keywords:** mathematical achievement, sex differences, school grades, math tests, self-concept

## **Introduction**

Despite the multitude of approaches to analyzing academic achievement in mathematics, some topics are far in the lead based on the number of publications, the intensity of discussion, and the variety of proposed theoretical models. These topics include the nature of sex differences in mathematical achievement—their size, change over time, causes and consequences for society. Despite extensive research into sex differences in mathematical achievement, many controversial issues and contradictions remain.

The objective of our research was to compare various methods for assessing mathematical achievement and to analyze sex differences observed with the use of the various methods.

## ***Measures of mathematical achievement***

Three types of measures are generally used to assess academic performance overall and mathematical achievement in particular: (a) school grades in individual subjects or, more frequently, grade point average (GPA) (for example, Kimball, 1989; McClure et al., 2011; Voyer & Voyer, 2014); (b) results of cognitive ability tests, standardized national assessments (such as the Graduate Record Examination in the U.S., the National Curriculum Tests in the UK, and the Unified State Examination, or USE, in Russia), and international tests that measure literacy and competency (such as the Program for International Student Assessment, or PISA) (for example, Benbow & Stanley, 1980, 1982; Hyde & Linn, 2006; Strand et al., 2006; Lohman & Lakin, 2009; Lindberg et al., 2010); and (c) self-assessment of mathematical achievement, which is frequently used in recent studies instead of direct assessment of academic achievement (for example, Spinath et al., 2008; Chamorro-Premuzic et al., 2010; Luo et al., 2011; Marsh et al., 2015; Seaton et al., 2014). Self-assessment is associated with a wide range of indicators, including direct self-appraisal of academic performance, achievement attitudes (self-concept, self-confidence, self-efficacy), extrinsic and intrinsic motivation, school anxiety, and personal indicators linked with subjects' own assessment of what they do better or worse—for example, selection of disciplines for advanced study, choice of college major, preference for a particular profession, etc.

All of these measures are associated with particular aspects of academic success and, predictably, correlate with each other. This creates the illusion that the measures are interchangeable in research. However, although the correlation in various measures of academic achievement is generally significant, it is not always very

high and, more importantly, the significant role that self-assessment of mathematical ability plays in mathematical achievement is not sufficient grounds for viewing it as a direct indicator of mathematical achievement.

Average correlation between math grades and test scores does not exceed 0.5 and is frequently even lower (Cucina et al., 2016). Thus, correlation between math grades and math test scores in studies with representative samples was in the 0.35–0.37 range for seventh-graders (Marsh et al., 2005) and in the 0.27–0.39 range for ninth-graders (Möller et al., 2014). The correlation of math self-concept with math grades and with test scores was similar at 0.38–0.44 and 0.28–0.32 (Marsh et al., 2005).

Differences among mathematical achievement indicators (grades, test scores, and self-concept) are also evident from analysis of their correspondence with other psychological traits.

Intelligence correlates more strongly with test scores than with school grades. For example, a comparison of intelligence measured by the Berlin Intelligence Structure (BIS) and the results of the Trends in International Mathematics and Science Study (TIMSS) yielded a correlation of 0.51 (Hofer et al., 2012). At the same time, a meta-analysis of the link between school grades in math and the mathematical subtests of various IQ tests found an average correlation of 0.43 based on 14 studies. The general factor in intelligence ( $g$ ), diagnosed using the U.S. Armed Services Vocational Aptitude Battery (ASVAB), is linked with scholastic performance at about the same level: Correlation with GPA was 0.44, while correlation with the math subtests of the ASVAB — Arithmetic Reasoning, Numerical Operations, and Mathematics Knowledge — was 0.39, 0.18, and 0.42, respectively (Roth et al., 2015).

Self-control and procrastination correlate more closely with self-reported school grades (0.52, -0.32) than with test scores (0.33, -0.04) (Hofer et al., 2012). Self-regulation has strong links with math grades and no correlation with math test scores (Morosanova et al., 2014). There also exist differences based on personality traits: College students pursuing degrees in mathematical sciences exhibited lower neuroticism scores than those studying humanities (Vedel, 2016).

Differences between school grades and test scores depend significantly on the distinctive roles these play in the formation of math self-concept. Math grades earned through direct interaction with a teacher are believed to have more impact than test scores, which can be viewed as formal indicators that are not related to goals set by students in their studies (Trautwein et al., 2006; Simzar et al., 2015). The link between school grades and traditional definitions of success makes grades a more effective incentive for the formation of a positive or negative math self-concept than standardized test scores (Skaalvik & Skaalvik, 2002).

A number of theoretical models address the correlation between academic achievement and self-concept. An analysis of the cause-and-effect relationship between self-concept and academic achievement based on school grades and test scores included a thorough review of the three models, covering three possible options for correlation with academic achievement indicators: the self-enhancement model, which presumes the influence of motivational components of self-concept on academic achievement (Marsh & Yeung, 1997); the skill development model, which focuses on the importance of academic achievement for the formation of

self-concept (Byrne, 1996); and the reciprocal effects model, which views academic achievement as a precursor to self-concept and self-concept as the basis for the formation of academic achievement (Marsh, 1990; Marsh et al., 1999; Valentine et al., 2004; Marsh & Craven, 2006).

A reciprocal internal/external frame of reference model has been formed on the basis of these three models (Marsh & Köller, 2004; Marsh et al., 2015). The first steps towards the establishment of this model were made quite a while ago (Marsh, 1986). According to this model, a student's self-concept of his or her performance in a particular school subject is formed based on both external and internal comparisons (in other words, with two frames of reference): first, comparing one's own achievement with that of other students, and, second, comparing one's achievement in various academic domains. In the former (social comparison), academic achievement is a determinant of self-concept (high math grades compared to other students improve one's math self-concept). In the latter (ipsative comparison), academic achievement in one domain lessens perceived ability in other domains (if one's math grades are higher than one's literature grades, subsequent successes in math will reduce one's relative literature self-concept, regardless of how one's literature grades compare to those of classmates).

The reciprocal internal/external frame of reference model has been supported by a number of experimental studies (for example, Möller et al., 2011; Xu et al., 2013; Möller et al., 2014; Niepel et al., 2014; Marsh et al., 2015). A meta-analysis of the results of 69 studies with a cumulative sample of 125,308 individuals clearly demonstrated the characteristics of different academic achievement indicators (Möller et al., 2009). The meta-analysis focused on studies where academic achievement was diagnosed based on school grades, test scores, and self-reports (including affective, motivational, and cognitive components, as well as self-efficacy). The key results of the meta-analysis were as follows:

1. Average correlation between mathematical achievement and math self-concept for the entire sample was 0.43. Correlation between verbal achievement and verbal self-concept was slightly lower (0.35).

Correlation between mathematical achievement and verbal achievement was higher for test scores than for school grades (0.74 vs. 0.54), while correlation between mathematical and verbal self-concepts was lower for test scores than for school grades (0.37 vs. 0.50).

2. Correlation between mathematical achievement and verbal achievement for all indicators (without separation between school grades and test scores) was significantly higher than the correlation between math and verbal self-concepts (0.67 vs. 0.10).

3. Analysis showed that paths leading from mathematical achievement and verbal achievement to corresponding self-concepts were positive (0.61 and 0.49), while cross-paths (mathematical achievement–verbal self-concept and verbal achievement–math self-concept) were negative (–0.21 and –0.27).

These results support the assumptions of the reciprocal internal/external frame of reference model and—of special importance in the context of the present article (which seeks in particular to compare various measures of mathematical achievement)—demonstrate the inadequacy of viewing different indicators of mathematical achievement as interchangeable.



### ***Sex differences in mathematical achievement measures***

Assessments of sex differences in mathematical achievement vary regardless of how they are measured—teacher-assigned school grades, test scores, or self-reporting. There are some contradictions in the data for all cases: Some studies show that boys do better, others that girls perform more strongly, and still others demonstrate a lack of sex differences. Nevertheless, the key trends are clear.

The first comprehensive review of sex differences in math grades (Kimball, 1989) established that girls get better math grades and that their superior performance (higher grades) can be seen as early as elementary school. This has been supported by later reviews (for example, Amrein & Berliner, 2002; Ding et al., 2006). In middle school, girls generally have a small advantage, which increases in high school and declines somewhat in college and beyond.

The first meta-analysis of school grades was conducted using 369 samples of school and college students from various countries (Voyer & Voyer, 2014). It confirmed the aforementioned age dynamics of sex differences. In particular, girls were furthest ahead of boys during adolescence: in 14 studies of high school students  $d = -0.18$  (hereinafter, a negative Cohen's  $d$  indicates that girls outperform boys). However, average differences across the samples—while showing better performance by girls—were minuscule ( $-d = 0.07$ ). Subsequent analysis of the results of studies with small samples that were not included in the meta-analysis also demonstrated a certain, but quite modest, advantage for girls ( $-d = 0.11$ ).

Based on the results of standardized tests, the mathematical achievement of boys and girls is completely reversed: Boys have higher scores based on standardized methods of assessing mathematical achievement. Boys do better on mathematical subtests of cognitive tests (Strand et al., 2006; Lohman, Lakin, 2009) and outperform girls on national math tests (Hyde et al., 1990; Else-Quest, 2010; Lindberg et al., 2010) as well as international mathematics competency tests (Mullis et al., 2008; Nosek et al., 2009). There are also more boys in the highest-scoring groups (Benbow & Stanley, 1980; Benbow, C. P., 1988; Wai et al., 2010; Korper-shoek et al., 2011).

Over the past 40 years, the gap between boys and girls in math test scores has consistently decreased, but it has not completely closed. Instead, it has plateaued at the same level (Ceci et al., 2014; Reilly et al., 2015; Wang, Degol, 2016). For example the average effect size ( $d$ ) for national performance data in National Assessment of Educational Progress mathematics (almost 2 million students) is 0.10 (i.e., sex differences are minimal).

Studies of math self-concept generally demonstrate higher self-confidence and self-efficacy for boys (Kling et al., 1999; Syzmanowicz & Furnham, 2011; Novikova & Kornilova, 2012). A meta-analysis of 54 studies conducted between 1997 and 2009 showed that self-reports of mathematical/logical intelligence by boys were much higher: almost half of a standard deviation above self-reports by girls. Only one study in the meta-analysis displayed higher self-reports by girls. Four others showed minuscule differences ( $d = 0.06$ ). For the entire sample, effect size ( $d$ ) reached 0.44 (Syzmanowicz & Furnham, 2011).

Thus, research results indicate that girls have higher mathematical achievement based on school grades and lower mathematical achievement based on test scores and math self-concept.



The research described below analyzed the manifestation of sex differences in mathematical achievement assessed using different measures. The new insights offered by the research relate first of all to the juxtaposition between the sex differences in mathematical ability observed in the general population and the sex differences observed in groups that self-select for STEM fields, and second to the analysis of within-family sex differences in mathematical ability.

## **Method**

Results from two studies were used to analyze sex differences in mathematical ability among high school students. The objective of the studies was to compare academic achievement of twins and singletons, but since they were carried out with samples representative of the general population of the relevant age, their results also provide a good illustration of sex differences in academic achievement.

### *Study 1*

The objective of the first study was to compare scholastic achievement of twins and singletons. The sample included monozygotic (MZ) twins, single-sex DZ twins, and opposite-sex DZ twins (total of 2,282 pairs), as well as singletons (4,065) from the same grades as the twins. The age of twins and singletons ranged from 8 to 17 (grades 2–11). The sample included about 2% of all school-age twins residing in Russia at the time of the study and was representative of the Russian school-age twin population based on socioeconomic status (SES), structure of family of origin, and characteristics of the region of residence—i.e., population size (from 3,000 to 10 million), economic development, and geographic location.

The present article only addresses mathematical achievement of high school students (grades 8–11). The sample included 1,234 pairs of twins (2,468 individuals: 1,315 girls and 1,153 boys, i.e., 53.28% vs. 46.72%) and 2,227 singletons (1,124 girls and 1,103 boys, i.e., 50.47% vs. 49.53%). The age of study participants ranged from 12 to 17 ( $M = 15.0$ ,  $SD = 1.43$ ).

Indicators: final school grades (2 as the lowest through 5 as the highest) in two academic subjects (algebra and geometry).

### *Study 2*

The objective of the second study was to compare scholastic achievement of twins and singletons based on the results of the Unified State Examination, which is taken by all high school graduates in Russia. Two academic subjects are mandatory components of the exam: Russian language and math. Unless excused for health reasons, all students must take the USE in order to get a high school diploma. Students applying to institutions of higher education must take additional exams in subjects based on their fields of study.

It should be noted that in the case of population studies, such as our research, the factor that the USE is most criticized for (violations of testing procedures) is not relevant for comparing mean group scores (e.g., twins vs. singletons or boys vs. girls), because the error is the same for all groups.

The sample of Study 2 includes all twins residing in Russia who took the USE in 2010–2012. Twin pairs were selected using the following algorithm: Students were

classified as twins if they shared a last name, patronymic, and date of birth, and took the test at the same location.

For the purposes of this study (comparing sex differences in school grades vs. in USE scores), all twins over the age of 19 were excluded from the sample. As a result, data were obtained on the USE test scores of 22,320 twins (11,160 single-sex and opposite-sex twin pairs, including 12,760 girls and 9,560 boys, i.e., 57.17% vs. 42.83%). The age of study participants ranged from 14 to 19 ( $M = 16.5$ ,  $SD = 0.59$ ).

In addition, a subsample of students from the entire sample of Study 2 was reviewed: individuals who took an optional physics exam in addition to the mandatory math exam (i.e., are likely to apply to institutions that specialize in STEM fields). From this viewpoint, a decision to take an optional physics exam is a good indicator of a positive math self-concept and self-confidence in mathematics.

The subsample of students who took the USE physics exam was 5,870 (1,705 girls and 4,165 boys, i.e., 29.05% vs. 70.95%).

Indicators: USE scores in mathematics, USE scores in mathematics of those who take an optional physics exam. USE scores range from 0 to 100.

The results of the two studies make it possible to analyze sex differences based on three indicators of mathematical achievement: math grades assigned by the teacher at the end of the school year, USE scores, and mathematical self-confidence (as assessed based on the selection of a specialization related to advanced study of mathematics).

Data processing was carried out using R-3.2.3 software (Wooden Christmas Tree). Student's  $t$ -distribution, the Pearson  $\chi^2$  criterion, and Cohen's effect size  $d$  were used to assess the significance of inter-group differences. Cohen's effect size  $d$  was calculated as the difference between the mean scores of boys and girls, divided by the average standard deviation for the groups of boys and girls. A positive  $d$  indicates that boys outperformed girls, while a negative  $d$  means that girls scored higher. The further  $d$  is from 0, the greater the sex difference in the given characteristic.

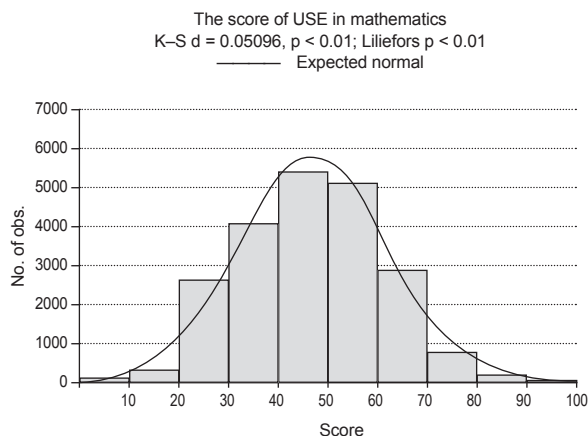
## Results

### *Frequency distribution of school grades and USE math scores*

Less than 0.5% of high school students received a final grade of 2 (on a scale of 2–5). It is unlikely that this reflects the number of students who successfully completed the curriculum. More plausibly, this indicator demonstrates tacit grading practices. A grade of 2 is an extraordinary event that has severe consequences for both students and teachers. Students who receive 2s may have problems advancing to the next grade level: The school has to schedule an additional exam in the fall and students who do not pass this exam must repeat the year. Students who receive 2s in their graduating year do not get their high school diploma. 2s also have consequences for teachers, because they are interpreted as an indicator of ineffective teaching and insufficient attention to weaker students. As a result, teachers tend to avoid “making trouble” for the students and for themselves, and “inflate” final grades of 2 to 3s.

Almost half of the students in grades 8–11 received 3s in math; 40% earned 4s and 12.5% got 5s. Thus, final grades highlight students with strong ability and interest in mathematics, but do not differentiate students who performed poorly from those who completely failed to progress through the curriculum.

Unlike with school grades, the distribution of USE math scores is closer to a standard bell curve (Figure 1). Scores in our sample range from 0 to 100 ( $M = 47.13$ ,  $SD = 15.07$ ).



**Figure 1.** USE Math score (frequency distribution)

USE scores are not only more useful for differentiating students based on mathematical ability, but also have a higher validity. Indirect proof of this is the balance in academic achievement of urban vs. rural dwellers.

It has been shown many times that the higher average SES of city residents, better access to high-quality education, a comprehensive extracurricular education offering, and a stronger orientation towards education all result in better academic performance by students who live in cities. Our study supports this: Students from urban communities scored much higher on the USE than students from rural areas (47.91 vs. 45.31,  $p < 0.001$ ).

The balance in the final school grades of urban vs. rural students is quite different. There is no difference in the mathematical achievement of urban and rural students (3.65 vs. 3.67,  $p = 0.53$ ). It is likely that teachers assign grades through a comparative assessment of students in their class, rather than based on an abstract federal education standard: Grades reflect relative performance (children who learned more than their classmates got the highest grades) rather than an absolute criterion (how well the curriculum had been absorbed).

Thus, even though the USE has been strongly criticized as a means of final testing, our data show that USE scores are more meaningful for comparative assessment of mathematical achievement than school grades.

### ***Comparing mathematical achievement of twins vs. singletons***

Assessing differences between twins and singletons is necessary in order to determine whether conclusions drawn from twin studies can be rightfully extended to

the overall population, which is mostly made up of singletons (95.2% in our sample). Therefore, the first objective of the research was to compare the mathematical achievement of twins and singletons in grades 8–11.

The frequency distribution of final grades in algebra and geometry (Table 1) does not show a significant difference between twin and singleton samples ( $\chi^2 = 0.26$ ,  $p = 0.88$  for algebra;  $\chi^2 = 0.23$ ,  $p = 0.89$  for geometry).

**Table 1.** Distribution of final grades in algebra and geometry (percent of sample) for students in grades 8–11

Final Grade	Twins (% of Sample)	Singletons (% of Sample)
<i>Algebra</i>		
3	48.26	47.51
4	39.14	39.77
5	12.60	12.72
<i>Geometry</i>		
3	47.58	47.63
4	39.72	39.24
5	12.70	13.13

Without going into further detail, we should note that performance was also compared within subgroups. No differences in mathematical achievement were observed between subgroups based on zygosity (monozygotic vs. dizygotic) or type (single-sex vs. opposite-sex). Thus, the study showed that zygosity does not affect scholastic achievement in algebra ( $\chi^2 = 3.97$ ,  $df = 4$ ,  $p = 0.41$ ) or geometry ( $\chi^2 = 6.78$ ,  $df = 4$ ,  $p = 0.14$ ). For more details, please see Zyrianova, 2009 a, b.

Table 2 provides data on the USE math scores of twin partners (4.8% of sample) and of all students (both twins and singletons, i.e., 100% of sample) who took the USE. The division of scores into subgroups, as well as the designation of the score levels (minimal, low, medium, and high) is based on the classification developed by the Federal Institute of Pedagogical Measurement, derived from USE math scores.

**Table 2.** Distribution of high school graduates by performance level (percent of sample) based on USE math scores

Performance Level	Twins (% of Sample)	All USE Takers (% of Sample)
Minimal	10.50	12.42
Low	65.58	65.80
Medium	22.79	20.84
High	1.13	0.94

Since no data are available on the USE math scores of only singleton students, it was not possible to conduct a statistical analysis of intergroup differences. However, by comparing the USE scores of twins vs. all USE takers, we can show that the mathematical achievement of twins is at least as strong as that of singletons. Thus, only 10.5% of twins received minimal USE scores (fewer than singletons with

minimal scores), while the percentage of twins who received medium or high USE scores was higher than that of singletons.

Both measures of academic performance by students (school grades and test scores) indicate that there are no systematic differences in the mathematical achievement of singletons and twins in grades 8–11.

### Sex differences in math grades

The distribution of boys vs. girls (percent of sample) in the sample of Study 1 was 46.73 vs. 53.28. Table 3 summarizes data on the algebra and geometry grades of twins and singletons, broken down by sex.

**Table 3.** Distribution of boys vs. girls (percent of sample) by final grade in algebra and geometry (grades 8–11)

Final Grade	Twins		Singletons	
	Boys (% of Sample)	Girls (% of Sample)	Boys (% of Sample)	Girls (% of Sample)
Algebra				
3	57.60	40.10	57.07	37.82
4	31.64	45.68	34.32	45.22
5	10.76	14.22	8.61	16.96
Geometry				
3	58.59	38.00	57.19	38.02
4	30.76	47.52	33.77	44.74
5	10.65	14.48	9.04	17.24

Girls earned higher math grades both in the twin group and in the singleton group. The differences were significant for both algebra and geometry:  $\chi^2 = 74.08$ ,  $p < 2.2e-16$  for boy twins vs. girl twins in algebra,  $\chi^2 = 89.02$ ,  $p < 2.2e-16$  for boy singletons vs. girl singletons in algebra,  $\chi^2 = 99.695$ ,  $p < 2.2e-16$  for boy twins vs. girl twins in geometry, and  $\chi^2 = 84.339$ ,  $p < 2.2e-16$  for boy singletons vs. girl singletons in geometry.

Students with 5s in both algebra and geometry included 304 girls (63.60%) and 181 boys (36.4%). Considering the fact that the number of boys and girls in the sample was almost equal (49.53% vs. 50.47%), we can conclude that the relative number of girls with top grades was higher. The size effect also attests to sex differences ( $d = -0.33$  for algebra and  $d = -0.41$  for geometry).

Since the average age of participants in Study 1 was 1.5 years younger than in Study 2, the performance of the graduating class (grade 11, mean age of 16.6) was analyzed separately. These results exhibited the same patterns as data for all high school students (no difference between twins vs. singletons in mathematical achievement and higher math grades for girls than for boys). The difference in the final grades of twins vs. singletons in 11th grade was insignificant in both algebra ( $\chi^2 = 0.26$ ,  $p = 0.877$ ) and geometry ( $\chi^2 = 0.23$ ,  $p = 0.893$ ). Girls had stronger scholastic performance than boys in both algebra ( $\chi^2 = 74.08$ ,  $p < 2.2e-16$ ) and geometry ( $\chi^2 = 99.695$ ,  $p = 2.2e-16$ ). Since the results for this subgroup did not differ from the results for the entire sample of Study 1, only data for all high school students are described henceforth.

### Sex differences in USE math scores

A comparison of the mean USE test scores of boys vs. girls yields completely different results. Boys score much higher than girls on USE math sections (Table 4) and have higher overall test scores on average (47.56 vs. 46.82,  $p < 0.001$ ), but the effect size is very close to zero ( $d = 0.05$ ).

**Table 4.** Sex differences in USE math scores: mean standard deviation, Cohen's  $d$

Sex	Mean	Standard Deviation	$t$ -Criterion	$F$ -Ratio	$d$
Boys	47.56	15.46	3.59	1.10	0.05
Girls	46.82	14.76	$p < 0.001$	$p < 0.001$	

Sex differences in math ability can be observed not only in comparing average scores, but also in analyzing variability (boys exhibit significantly higher variation in mathematical achievement). The difference in variability is also significant when comparing extreme groups (previously described in detail, see Chertkova & Egorova, 2013 and Chertkova & Pyankova, 2014).

It was not possible to isolate extreme subgroups based on school grades in Study 1: The aforementioned tendency of teachers to avoid the lowest grades means that there are virtually no 2s in math, while almost half of the students get 3s.

**Table 5.** Number of boys and girls in extreme groups of USE math scores

USE Score	Number in group		% of Extreme Group		% of Entire Sample	
	Boys	Girls	Boys	Girls	Boys	Girls
<i>Criterion for group selection: <math>M \pm 2\sigma</math></i>						
Low USE scores	192	260	42.48%	57.52%	2.01%	2.04%
High USE scores	224	162	58.03%	41.97%	2.34%	1.27%
<i>Criterion for group selection: 0.5% tails of distribution</i>						
Low USE scores	47	54	46.53%	53.47%	0.49%	0.42%
High USE scores	48	31	60.76%	39.24%	0.50%	0.24%

The distribution of mathematical achievement indicators in Study 2 is close to the normal distribution curve, which makes it possible to analyze the ratio of boys to girls in extreme groups. The sample size allowed us to isolate extreme subgroups using two types of criteria. First, two groups of high school students were selected whose USE math scores were at least 2 standard deviations away from the mean ( $M \pm 2\sigma$ , soft criterion). The group of lowest-performing students included twins who received a score of no more than 16 points on a scale of 0–100 (452 students). The group of highest-performing students included twins who received a score of at least 79 points (386 students). Second, students who received the lowest 0.5% and highest 0.5% of scores among all USE test takers were separated out (hard criterion). The former received a score of no more than 5 points (101 students); the

latter received a score of at least 90 points (79 students). Table 5 summarizes the distribution of boys vs. girls in these extreme groups.

The ratio of boys to girls in the group of the lowest-performing students based on the soft criterion was proportional to the overall ratio of boys to girls in the entire sample (Study 2 had 42.84% boys vs. 57.16% girls). The highest-performing group had significantly more boys than girls (58.3% vs. 41.97%,  $\chi^2 = 37.06$ ,  $p = 8.958 \times 10^{-9}$ ). With the use of the hard criterion, the proportion of boys in either tail of the distribution was relatively higher ( $\chi^2 = 10.995$ ,  $p = 0.004$ ).

The ratio of boys to girls among the highest-performing students based on the soft criterion was 1.38. The ratio of boys to girls among the highest-scoring students based on the hard criterion was 1.55.

For the entire sample, 2.34% of boys were in the highest-performing group based on the soft criterion and 0.50% based on the hard criterion. The percentage of girls in the top-performing group was 1.27% based on the soft criterion and 0.24% based on the hard criterion. Thus, there were twice as many boys as girls in the top tail of the USE math score distribution curve (ratio of 1.84 based on one criterion and 2.08 based on the other). The harder the selection criterion, the greater the advantage of boys over girls in the highest-scoring group.

### ***Sex differences in academic achievement of twins from opposite-sex pairs***

Analysis of the twin sample in the study made it possible to compare the performance of boys and girls from opposite-sex twin pairs and assess whether environmental factors related to having a co-twin of the opposite sex affect sex differences in mathematical ability.

The sample in Study 1 included 254 opposite-sex twin pairs; the sample in Study 2 included 2,562 opposite-sex pairs. Table 6 presents data on scholastic mathematical achievement of boys and girls from opposite-sex pairs.

**Table 6.** Sex differences in math grades and USE scores for twins from opposite-sex pairs: descriptive statistics and Cohen's  $d$

Mathematical achievement	Boys		Girls		$\chi^2$	$t$	$d$
	M	SD	M	SD			
Algebra grades	3.52	0.72	3.77	0.73	14.630		-0.34
Geometry grades	3.52	0.73	3.72	0.71	14.663		-0.28
USE scores	47.85	14.79	47.85	14.69		0.006	0.00

Data from Study 1 show that practically all opposite-sex twins had similar grades in algebra and in geometry—i.e., those who do well in algebra do well in geometry and vice versa.

Girls had better grades in both subjects than boys ( $\chi^2 = 14.630$ ,  $p = 0.0006$  for algebra;  $\chi^2 = 14.663$ ,  $p = 0.0006$  for geometry), which is in line with the results obtained for the entire sample. However, effect size for opposite-sex twin pairs was somewhat lower than for the entire sample ( $d = -0.28$  vs.  $d = -0.41$ ).

A comparison of the USE math scores of opposite-sex twins (Study 2) yields somewhat different results than those for the entire sample: Boys from opposite-sex



twin pairs had USE math scores comparable to boys from the entire sample (47.45 vs. 47.85,  $p = 0.26$ ); however, girls from opposite-sex pairs had significantly different scores (46.55 vs. 47.85,  $p < 0.01$ ): Girls from opposite-sex pairs performed much better on the USE math section than girls from the entire sample.

Effect size ( $d$ ), which showed a slight advantage for boys in the entire sample, indicates that there were no sex differences in mathematical achievement in opposite-sex twin pairs ( $d = 0.00$ ).

### ***Positive mathematical self-concept***

To graduate, high school students take two mandatory exams (mathematics and Russian language) and several optional exams in subjects they select. The choice of additional exams is not completely free and depends on the major a student wants to pursue in college. Educational institutions that offer STEM programs require applicants to take exams not only in math but also in physics. For this reason, USE test takers who select an optional physics exam in addition to the mandatory sections most likely intend to study mathematics in college and then enter STEM fields. Based on this reasoning, an optional physics exam can be viewed as an indicator of positive self-concept and self-confidence in mathematics.

A subgroup of twins who took the USE physics exam was selected from the entire sample of Study 2. Table 7 lists the mean scores that these students received on the USE math section.

**Table 7.** USE math scores of students who took an optional physics exam: descriptive statistics and Cohen's  $d$

	Mean	SD	<i>t</i> -Criterion	<i>F</i> -Ratio	<i>d</i>
Boys	52.87	14.99	-4.54	1.05	-0.13
Girls	54.83	14.66	$p < 0.001$		

Among students who expressed interest in STEM fields, there were significantly more boys than girls. At the same time, the girls in this subgroup scored higher on the USE math section than the boys (average score of 54.83 for girls and 52.87 for boys,  $p < 0.001$ ). Effect size ( $d$ ) was -0.13, which suggests a small sex difference; at the same time, for the entire sample, effect size was smaller and opposite in direction. In other words, data for the entire sample showed a certain advantage for boys, but girls outperformed boys in mathematical achievement in the subgroup of students with a higher positive mathematical self-concept.

### **Discussion**

Data obtained through a comparison of the school grades and USE scores of girls and boys were in line with the results of most studies: Girls had higher algebra and geometry grades, but slightly lower USE scores.

Let us note above all that differences between the USE scores of boys and girls were small: There was a statistically significant mean difference, but negligible effect size. Data on changes in the mathematical achievement of boys and girls over the past decade show that sex differences have been decreasing. Thus, in 2003, there

was an 11-point gap in the math scores of Russian eighth-grade boys and girls on the Trends in International Mathematics and Science Study (TIMSS). The average difference in the scores of eighth-graders from 34 countries was 8.6 points; raw score gaps ranged from -27 to +29 (Nasic et al., 2009). In 2011, the gap in the scores of Russian eighth-graders was only 1 point and in favor of the girls (Mullis et al., 2012). Shrinking sex differences in mathematical achievement can be observed in various countries; the advantage of boys in a meta-analysis was small (Cohen's  $d = 0.05$ ) and coincided with data obtained in our research ( $d = 0.06$ ).

Our study demonstrated much larger differences in the school grades of boys and girls. Effect sizes in final grades in algebra and geometry equaled -0.33 and -0.41, respectively. A meta-analysis of sex differences in school grades (Voyer & Voyer, 2014) indicated that girls in older grades performed better in math, but the difference between boys and girls was smaller: Cohen's  $d = -0.18$ .

There are no unequivocal explanations for the opposite directions in sex differences based on various measures of mathematical achievement, despite the hundreds of studies conducted. The dynamics are not as simple as they might appear at first glance. There is no empirical evidence for "obvious" explanations (e.g., that teachers favor diligent and hard-working girls and give them better grades, while boys have better math abilities on average and therefore outperform girls on tests where a teacher's personal feelings do not have an effect). For example, data from USA show that teachers encourage boys more during lessons, call on boys more frequently, and respond to boys' questions more often in conditions of comparable initiative by boys and girls (Jones & Dindia, 2004). The interpretation of sex differences requires consideration of more complex mechanisms related to self-concept and extrinsic/intrinsic motivation. These interrelated psychological traits—each of which is a complex construct—reveal many direct and indirect links with sex differences in both school grades and test scores. The interplay of beliefs, motivations, learning styles, and academic achievement is also vital to understanding sex differences (Lee et al., 2014; Muis, 2014; Gaspard et al., 2015; Guo et al., 2015).

Our research also supported the link with mathematical self-concept: Girls who selected an optional USE physics exam (i.e., have a positive math self-concept and intend to pursue degrees linked with math) received better USE scores than boys overall, as well as better than boys who plan to continue studying mathematics. It appears that a positive math self-concept requires a higher degree of security from girls than from boys. The only study we have seen that takes an analogous approach yielded similar results (Korpershoek et al., 2011). As in our study, high school students in the Netherlands selected sections to take as part of their final school examination. Less than 12% of students took math, physics, and chemistry exams: girls were in the minority in this group, but they outperformed boys on the math exam. In other words, among boys and girls with the same math grades, boys appear to have higher confidence in their readiness to enter STEM fields and are more likely to pursue STEM degrees than girls.

Another comparison of boys and girls in our study was conducted using the group of opposite-sex DZ twins. Many studies of twins and singletons indicate that twins lag in cognitive development: they have lower intelligence scores and weaker academic performance (for example, Deary et al., 2005; Ronalds, et al., 2005; Christensen et al., 2006; Voracek & Haubner, 2008; Behrman, 2015). However, with age these dif-

ferences decrease significantly or even disappear (Deary et al., 2006; Webbink et al., 2008; Calvin et al., 2009; Eriksen et al., 2012). Our study showed that high-school-age twins do not have inferior school grades or USE test scores than singletons.

Twin samples allow quasi-experimental designs that are impossible with singleton samples. Thus, a comparison of boys and girls from opposite-sex twin pairs equalizes a range of parameters including age and certain family and school environment indicators (socioeconomic status, personality traits of parents, parenting styles, etc.) This significantly cuts down on characteristics that can affect the development or absence of sex differences.

The girls from opposite-sex DZ pairs in our study showed no difference from their twin brothers in mathematical achievement based on USE scores. This result suggests that the concept of gender-differentiated parental expectations (expectations of higher mathematical achievement by boys), which has been widely discussed over the last decade and a half, is unlikely to be a significant moderator of mathematical achievement. Two hypotheses with contradictory implications can be put forth regarding the results obtained in the study (the parity in mathematical achievement of boys and girls from opposite-sex twin pairs).

The first relates to the similar environment of DZ pairs: Twins spend a lot of time together and share each other's interests, which leads to comparable mathematical achievement. This hypothesis requires further study at the very least, since DZ twins, particularly opposite-sex twins, tend towards divergence rather than convergence of activities and interests. Furthermore, this hypothesis does not appear convincing in light of data on differences in the mathematical abilities of siblings regardless of birth order (Cheng et al., 2012), as well as data on low mathematical achievement of adopted children (van Ijzendoorn et al., 2005).

The second hypothesis hinges on the link between mathematical ability and prenatal testosterone levels (twin testosterone transfer hypothesis). There is a theory that during the prenatal period, having an opposite-sex co-twin can change the level of prenatal testosterone, resulting in differentiated brain structure and masculinization of girls (Tapp et al., 2011; Ahrenfeldt et al., 2015). This means that girls from opposite-sex pairs are more likely to pursue activities linked to the development of spatial abilities (Berenbaum et al., 2012; Constantinescu & Hines, 2012) and have fewer differences from boys in mathematical ability and mathematical achievement (as found in our study). Thus, biological factors related to the formation of mathematical ability could be linked with sex differences as well. Moreover, they could contribute significantly to sex difference indicators such as dispersion of mathematical ability (which is higher for boys in our study as well as in other studies) and the greater proportion of boys in the highest-achieving groups (our study showed that the ratio of boys to girls in the highest-achieving groups was approximately 2:1).

## **Conclusion**

Academic achievement in math differs for boys and girls, but the direction of difference varies depending on how achievement is measured. Girls have higher school grades while boys have higher USE test scores.

The number of boys in the right tail of distribution is greater than the number of girls.

Within the group of high school students with a positive mathematical self-concept, girls outperform boys in mathematical achievement.

Girls from opposite-sex DZ pairs show better mathematical achievement than singleton girls in their age group and do not differ in mathematical ability from boys.

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## Development-focused educational texts as a basis for learners' intellectual development in studying mathematics (DET technology)

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The article discusses an innovative teaching technology that uses development-focused educational texts (DET Technology) to stimulate school pupils' intellectual development in grades 5 to 9. It describes the psychological and psychodidactic framework of DET Technology. Development-focused educational texts are distinctive in that they use a framework of academic mathematical knowledge to build up the key components of pupils' mental experience (cognitive, conceptual, metacognitive, and intentional). Such texts also provide the conditions for the development and usage of students' personal learning styles. The article outlines the psychodidactic types of development-focused educational texts and the requirements that the psychodidactics proposes for educational texts.

**Keywords:** psychodidactics, intellectual development, development-focused educational text, mental experience, DET technology

### Introduction

People's intellectual abilities have started to be considered a key factor in social development due to the current challenges facing people today. Therefore, it is hardly surprising to observe a growing focus on school education and, above all, on innovative teaching technologies because the comprehensive school is a fundamental social institution that reproduces and enhances a society's intellectual resources.

The traditional, *subject-centered* teaching system assesses the effectiveness of pupils' education based primarily on their knowledge, capabilities, and skills in a particular school subject. In contrast, innovative teaching technologies that use the *psychodidactic* approach switch the main focus when evaluating teaching effectiveness to changes in a pupils' intelligence and personality that characterize them as being able to respond successfully to contemporary social challenges.

Psychodidactics is the area of pedagogy that designs content, forms, and methods of teaching based on integrated psychological, didactic, methodological and subject-matter knowledge while focusing specifically on the mental patterns of personality development as a basis for organizing the teaching process and general learning environment (Davydov, 1966; Panov, 2004; Gelfman and Kholodnaya, 2006; et al.).

Psychodidactic efforts result in a qualitatively new teaching product that combines psychological, didactic, methodological and subject-matter knowledge. That product could be a new schooling environment, an innovative teaching technology, a development-focused training method or a next-generation textbook. The psychodidactic approach involves *pedagogical engineering*, i.e., the design, structuring and use of teaching products that focus specifically on developing the mental resources of each child. The main goal of psychodidactics is to provide an environment that promotes children's psychological growth by teaching a given subject more effectively.

The psychodidactic approach may be used in schools in many ways, e.g.:

- by using “didactical situations” as a teaching technique to shape pupils’ knowledge, including the use of metaphor and emotional context (Brousseau 1997);
- through focusing on learning and conceptualization by selecting mathematical tasks and hypothesizing about how each one influences the learning process (*hypothetical learning trajectory*, or *HLT*) (Simon, Tzur, 2004);
- by using basic cognitive actions such as recognizing, building-with and constructing (RBC model) as a foundation for conceptual teaching based on pupils’ own experience (Hershkowitz et al., 2001; Bikner-Ahsbahs 2004);
- by developing pupils’ creative thinking (Burke and Williams 2008); and
- by using “realistic” situations in the learning process (RME) (Van den Heuvel-Panhuizen & Drijvers, 2014).

The actual content of school subjects is essential to pupils’ intellectual development. It is therefore very important to set the requirements applied to the teaching content. This includes school textbooks that could be used to implement the psychodidactic approach.

We believe that a textbook should not be structured as a reference/problem book. Rather, it should be a learner-focused teaching book because mathematical knowledge can have a developmental effect only when it is in harmony with the patterns of pupils’ mental development (intellectual and personal). Moreover, the work that learners do with the teaching texts—e.g., their own analysis, identification of key ideas, interpretation, and text writing—is a powerful resource for intellectual development. Ignoring the option of this type of work would mean denying pupils the opportunity to do “quiet” intellectual work on their own.

We developed *Development-focused Educational Texts (DET) Technology* as part of the *Mathematics. Psychology. Intelligence (MPI)* pedagogical project for use in teaching middle-school mathematics (years 5 to 9). DET Technology focuses on pupils’ intellectual development based on *mathematics content* and special-purpose *educational texts* (Gelfman and Kholodnaya 2006; Kholodnaya, Gelfman 2016).

This article explains the psychological and psychodidactic foundation of DET Technology and outlines the requirements applied to educational texts that focus on pupils' intellectual development.

### **Educational texts as a way to foster pupils' intellectual development**

When assessing the role of school education content as a whole and the role of educational texts in particular, one must appreciate the key fact that from the psychological perspective, intellectual development is possible only through learning, processing and producing diverse subject content, ranging from trivial everyday knowledge to scientific hypotheses about the structure of the universe. The richer the subject-matter environment (physical, social and educational) surrounding a preschooler or schoolchild, and the more actively they interact with this environment, the greater their intellectual ability will be. Moreover, the quality of subject content is fundamentally important. The developmental effect will differ depending on whether the learner studies by reading only normative texts or by reading texts that are open and thought-provoking and whether she/he learns mathematics by solving many similar tasks or by doing her/his own research.

Therefore, *the content of school education* is a key factor in the development of pupils' intelligence. Its minimum component is *the educational text*, which shapes the way pupils interact with various content environments.

In a wider sense, *the educational mathematical text* is any set of signs and symbols from the language of mathematics or the natural (Russian) language that carries a mathematical meaning. Consequently, educational mathematical texts range from detailed theoretical descriptions to individual tasks (e.g., problems, formulas, diagrams, drawings).

The text is the most valuable culture element and is essential for teaching. The important role of texts in personal intellectual development is noted by many scholars. They consider the text to be "a thinking structure" (V.V. Ivanov), "a model of thought adventures" (L.E. Gendenshtein) and "a conversation partner" (M.M. Bakhtin). Texts are a natural medium for intellectual development throughout a person's lifetime. In a wider sense, a "text" is a message that a person has to read and interpret about, including everyday situations, natural phenomena, and the behavior of others.

Texts, whether scientific, historical, cultural, fictional or educational, are not linear. An educational text should be designed as a multi-dimensional semantic space allowing the reader to travel mentally in different directions.

Development-focused educational texts are a type of *hypertext* characterized by the following:

- *Nonlinearity*. The "nucleus" or subject-matter knowledge in development-focused texts is supported by transitions from normative text fragments to topical discussion elements, including non-subject-related texts (stories, play elements, practical physics, ecology and psychology knowledge).
- *Diversity*. These texts contain elements with differing degrees of complexity in both content and learning methods (e.g., texts and tasks of various difficulty levels, normative texts containing templates and open texts, learning

through performance, research, projects and creative work). They employ various genres and types of texts (e.g., narrative, explanatory, discursive, problem-focused, “impossible”) and involve numerous ways of presenting knowledge (verbal/logical, visual, substantive/practical, emotional/meta-phorical).

- *Incompleteness, ambiguity and contradiction.* The educational texts contain an element of uncertainty, which is increased by questions addressed to the learner. The main benefit of this is that it stimulates a desire to eliminate uncertainty, which is a key aspect of creativity.
- *Personal involvement.* This effect is created through dialogue (including questions to the reader); structuring the text as a narrative—which is essential for supporting pupils emotionally and harnessing their everyday experiences—and by offering a selection of ways to study depending on the pupil's level of training, preferences and individual learning style. Pupils should be able to move on to the deeper levels in the text and recover non-verbal implications by relying on words' connotative meanings and their personal experience, associations and imagination.
- *Navigation (migration) across the text.* Learners can transfer from textbook texts to narrative teaching books, workbooks or electronic materials. In the workbook, they can undertake tasks of different complexity levels and use computer software to self-check and develop the required skills. The textbooks contain navigation tools (a navigation bar with special icons) that enable pupils to use the teaching set components according to their learning needs.
- *Self-sufficiency.* The educational texts are constructed in a way that knowledge is never easily available. Pupils need to approach new concepts and definitions gradually on their own while acquiring the necessary self-checking skills (e.g., willingness to pause, reflect and then possibly spot a mistake in the discourse). Texts that encourage pupils to write their own content unaided play an important role.

Therefore, next-generation educational texts are development-focused texts that provide teachers with a variety of learning trajectories depending on the child's needs.

In school education, texts are always the focus of attention because of their essential role in effective teaching (Eason et al., 2012; Geary, 2011; Siegler et al., Osmolovskaya, 2014, et al.). “Reader-oriented theory” suggests that readers actively construct meanings (concepts) as they read, which also applies to reading mathematics textbooks (Weinberg and Wiesner 2011).

Noting the importance of educational texts in school mathematics, we can push the limits of the popular view that teaching mathematics simply means teaching pupils how to solve mathematical problems. We believe that teaching mathematics actually means teaching children how to interpret the meanings and implications of mathematical concepts and operations. By working on educational texts, pupils can achieve a high level of understanding, which, in turn, will enable them to solve problems.

Therefore, the use of special *development-focused educational texts* that meet specific psychodidactic requirements is a promising way to encourage intellectual development. It means that development-focused educational texts do not merely present formal mathematical knowledge; they facilitate the development of psychological mechanisms for productive intellectual activity.

The question that needs to be answered is what should be the psychological basis of development-focused mathematical texts so they can boost pupils' intellectual development.

### **Enrichment of mental experience as the psychological basis for pupils' intellectual development**

We believe that the psychological basis for intellectual development should be the enrichment of pupils' mental experiences while learning.

The structural model of intelligence, as viewed in terms of the architecture of a person's mental experience, outlines four levels of mental experience, each with its specific purpose (Kholodnaya 2002; 2004):

- 1) *Cognitive experience* refers to the mental structures ("cognitive schemes") responsible for presenting, recognizing, storing and sorting information. Their main role is immediate information processing.
- 2) *Conceptual experience* refers to mental structures ("concepts") that generalize and transform information through abstraction, idealization and interpretation. Their main purpose is to identify meaningful properties and reproduce regular and consistent features of the environment.
- 3) *Metacognitive experience* refers to mental structures ("metacognitions") that allow involuntary and voluntary regulation of information processing and conscious control over how intelligence works. Their main purpose is to control intellectual activity and the status of personal intellectual resources.
- 4) *Intentional (emotional and evaluative) experience* refers to the mental structures ("intentions") underlying individual cognitive dispositions. The main purpose of these structures is to form subjective preferences in selecting, e.g., subject areas, ways of solving problems, and information sources.

The way cognitive, conceptual, metacognitive and intentional experience is organized defines the *productive properties* of an individual's intelligence (cognitive, conceptual, metacognitive, creative abilities) and the *stylistic properties* (information-encoding styles, information-processing styles, thinking styles and epistemological styles). As intelligence develops, its productive and stylistic properties provide a foundation for integral intellectual abilities, including competence, talent and wisdom, which are the forms of intellectual giftedness.

If we define intelligence as the profile of an individual's mental experience, then we can suggest that each pupil brings his own mental experience that predetermines the nature of his intellectual activity in a given situation. The content and structure of this mental experience differ from one pupil to the next, which means that children's intellectual ability will vary. However, they all need an environment



that can facilitate their intellectual development through maximal enrichment of their personal mental experience.

“Enrichment” here includes, first, the development of each pupil’s key mental experience components (such as cognitive, conceptual, metacognitive and intentional experience) as a foundation for nurturing their intellectual abilities, Second, it establishes the conditions for pupils to demonstrate their individual cognitive styles.

In short, we can summarize the task of boosting pupils’ intellectual development using the following propositions:

- Each pupil carries his own mental experience and therefore has certain initial intellectual resources. Due to the structural and content distinctiveness of each pupil’s mental experiences, each individual is “clever in his own way”.
- In school education, pedagogical efforts target the content and structure of mental experience, including its cognitive, conceptual, metacognitive and intentional components.
- The mechanisms of an individual’s intellectual growth are linked to processes within that person’s mental experience and arise when experience components are sophisticated and enriched.
- Each pupil has her own potential for strengthening intellectual abilities, and the teacher’s task is to provide the necessary support by customizing classroom and after-school activities to their abilities.

### **Psychodidactic typology of educational texts**

*DET Technology* suggests that efforts to enrich pupils’ mental experience through development-focused educational mathematical texts should mainly focus on the following (Gelfman, Kholodnaya 2006; Kholodnaya, Gelfman, 2016):

- *Enrichment of cognitive experience.* This should seek to develop the use of different *ways of information encoding* (verbal/symbolic, visual, substantive/practical, sensory/emotional), to widen the range of *declarative and procedural cognitive schemes* for mathematical concepts and activity methods and to increase their flexibility.
- *Enrichment of conceptual experience.* This involves improving students’ understanding of mathematical language *semantics*, expanding the semantic fields pertaining to mathematical concepts, and differentiating and integrating verbal and non-verbal semantic structures. It also focuses on helping students identify *substantial conceptual features* and *links between concepts* from different generalization levels. It relies on independent *concept building* based on hypothesizing. Moreover, it takes into account the main *phases of conceptualization*, such as motivation, categorization, enrichment, transfer and crystallization.
- *Enrichment of metacognitive experience.* This enrichment should help develop *voluntary and involuntary control* of intellectual activity, including the ability to plan, evaluate, predict, and self-check. . Its aim is to *increase*



*metacognitive awareness*—in other words, the student’s understanding of how academic knowledge is organized and differences between learning methods. It encourages an *open cognitive position*, which means that it encourages a readiness, e.g., to absorb “impossible” information, accept an alternative point of view, and properly react to discrepancies.

- *Enrichment of intentional (emotional and evaluative) experience.* This means offering students a *choice* of how to study educational materials. It relies on *the pupil’s personal and intuitive experience*. (tudents are encouraged to share doubts, guesses, beliefs, “anticipatory” ideas and emotional evaluations.) *Play elements* are used, and there is a *value-based approach* to educational materials. The efforts should also include promoting multiple individual cognitive styles that reflect personal preferences and dispositions.

Based on the structural model of intelligence, different development-focused educational texts were designed for the school mathematics courses (years 5 to 9). Each type of mathematics teaching text addressed a specific component of the mental experience framework with the aim of facilitating its development (Gelfman and Kholodnaya 2006; Kholodnaya and Gelfman, 2016).

Table 1 describes the *psychodidactic typology of development-focused educational texts* (using the example of mathematics teaching texts).

**Table 1.** Psychodidactic typology of development-focused educational texts

Forms of mental experience	Components of mental experience structure	Characteristics of educational activity	Types of development-focused educational texts
Cognitive experience	Information-encoding ways	Verbal/symbolic information encoding	<ul style="list-style-type: none"> <li>• learning mathematical symbols</li> <li>• finding a formula</li> <li>• drafting definitions</li> </ul>
		Visual information encoding	<ul style="list-style-type: none"> <li>• developing a normative image</li> <li>• image classification</li> <li>• image evolution</li> <li>• new image motivation</li> <li>• conversion from verbal/symbolic to visual encoding</li> <li>• initiation of personal imaginative experience</li> </ul>
		Substantive/practical information encoding	<ul style="list-style-type: none"> <li>• laboratory work</li> <li>• situation in practice</li> </ul>
		Sensory/emotional information encoding	<ul style="list-style-type: none"> <li>• emotional impression</li> <li>• metaphor</li> <li>• play</li> </ul>
	Declarative cognitive schemes	Cognitive schemes of mathematical concepts	<ul style="list-style-type: none"> <li>• introduction of focus example</li> <li>• frame of concept</li> <li>• summary</li> </ul>
	Procedural cognitive schemes	Cognitive schemes of mathematical activity methods	<ul style="list-style-type: none"> <li>• algorithm (procedure)</li> <li>• operation</li> </ul>

Table 1 (concluded)

Forms of mental experience	Components of mental experience structure	Characteristics of educational activity	Types of development-focused educational texts
Conceptual experience	Semantic structures	Mathematical language semantics	<ul style="list-style-type: none"> <li>• term meaning</li> <li>• systematization of term meanings</li> <li>• translation from the language of mathematical symbols to native language</li> </ul>
	Category structures	Identification of category features and establishment of links between categories	<ul style="list-style-type: none"> <li>• identification of concept features</li> <li>• selection of concept features</li> <li>• establishment of links between concepts</li> <li>• concept motivation</li> <li>• concept categorization</li> <li>• enrichment of conceptual content</li> <li>• transfer of a concept to a new situation</li> <li>• crystallization of conceptual content</li> </ul>
	Generative structures	Concept building and the creation of own texts; interpretation and modeling	<ul style="list-style-type: none"> <li>• searching for and generalizing regularities</li> <li>• micro essay</li> <li>• modeling</li> <li>• independent writing of an original text</li> <li>• the invitation to the project</li> </ul>
Metacognitive experience	Involuntary and voluntary intellectual control	Planning	<ul style="list-style-type: none"> <li>• program</li> <li>• goal selection</li> <li>• planning</li> </ul>
		Predicting	<ul style="list-style-type: none"> <li>• developing a hypothesis</li> <li>• prediction in an uncertain situation</li> <li>• predicting operation results</li> </ul>
		Self-checking	<ul style="list-style-type: none"> <li>• self-checking methods</li> <li>• choosing a self-checking method</li> <li>• search for mistakes</li> </ul>
	Metacognitive awareness	Understanding methods of mathematical activity and own intellectual resources	<ul style="list-style-type: none"> <li>• reflection on solution methods</li> <li>• self-assessment of personal knowledge and skills</li> <li>• educational self-monitoring</li> <li>• psychological commentary</li> </ul>
	Open cognitive position	Readiness to work with inconsistent information	<ul style="list-style-type: none"> <li>• problematization</li> <li>• alternative</li> <li>• contrasting opinions</li> <li>• impossible situation</li> </ul>
Intentional (emotional and evaluative) experience	Preferences Beliefs Attitudes	Choice of learning method	<ul style="list-style-type: none"> <li>• selection of activity methods</li> <li>• selection of cognitive position</li> <li>• initiation and formation of individual cognitive styles</li> </ul>
		Use of intuitive experience	<ul style="list-style-type: none"> <li>• conjecture</li> <li>• creative work</li> </ul>
		Value-based treatment of educational material	<ul style="list-style-type: none"> <li>• mathematics and the wider world</li> <li>• key directions in mathematics</li> <li>• development</li> <li>• history of mathematics</li> </ul>

It should be stressed that each text type in Figure 1 is a type of prototype text with an invariable characteristic (its focus on a certain mental experience component) and variable semantic characteristics that depend on the curriculum topic. Moreover, texts of each type could serve as microtexts within a larger educational text; therefore, one text can contain several types of educational texts.

### **Psychodidactic requirements applied to development-focused educational texts**

The *Mathematics. Psychology. Intelligence. (MPI)* project and *DET Technology* offer the psychodidactic requirements for mathematics teaching using development-focused educational texts that form the content of textbooks, problem books, workbooks and electronic materials used to teach pupils in school years 5–6 and 7–9.

The proposed requirements are:

- 1) *Topic-based structure of mathematics course.* Each textbook/teaching book is devoted to a specific topic. For example, in year 5, the topics are ‘Natural numbers and decimals’ and ‘Positive and negative numbers’. In year 6, the topics include ‘Solving equations’, ‘Divisibility of numbers’, ‘Rational numbers’, and ‘Coordinates. Diagrams. Symmetry.’ The same principle of content arrangement is used in the textbooks for years 7–9. Topic-based teaching allows the topic to be developed consistently and the “immersion” teaching technique to be used with the help of teaching material on a deep, broad level using a variety of text types (instructions, explanations, stories, and history and psychology texts).
- 2) *Polymodality.* Texts provide multiple approaches to information presentation (verbal/logical, visual, substantive/practical, emotional/metaphorical), different methods of learning mathematical concepts (rationalization, case studies, use of “impossible” aspects of mathematics), different forms of learning activities (performance, research, project-based and creative work) and different self-check methods.
- 3) *Integration of declarative, procedural, metacognitive and value knowledge.* In addition to systematizing mathematical concepts, special emphasis is placed on teaching pupils how to learn effectively and efficiently. Pupils are taught (including through project assignments) how to understand algorithms, to solve text-based problems, to choose a rational solution method, and to analyse one and the same problem in a variety of ways, among other skills. Moreover, certain texts give pupils information about their own intellectual qualities, about the way academic knowledge is structured and about how they can acquire it. Finally, the texts describe possible attitudes towards facts, phenomena, actions, and conclusions, which helps stimulate pupils’ ability to express their own judgment.
- 4) *Focus on understanding mathematical facts and ideas.* The educational texts rely on the psychology underlying conceptualization. Their aim is to promote different information-encoding methods, to establish cognitive schemes pertaining to mathematical concepts and operations, to work with

the semantics of mathematical language, and to find concept features and links between concepts. They also reflect the stages of conceptualization; in particular, they encourage the introduction of new mathematical concepts. These educational texts facilitate the development of the general intellectual skills that are involved in understanding, such as the ability to argue, evaluate, substantiate, plan, predict and react correctly to inconsistencies and research.

- 5) *Development of a reflective position.* The content of teaching materials—i.e., the structure of each topic and the questions and tasks provided—is arranged to promote reflection among students or a conscious, voluntary attitude towards the learning process. The materials present knowledge gradually and slowly, providing a detailed exploration of the various aspects of the mathematical object introduced. This enables pupils, e.g., to evaluate gaps in their knowledge and the reasons behind them and to understand how different methods can be used to solve the same problem.
- 6) *Dialogue.* Development-focused educational texts are designed as dialogues with the reader. They include questions relating to topical situations and encourage discussions of alternative viewpoints. They also teach students how to express, substantiate and defend their opinion. Story-based educational books have a special place in DETs since the dialogue involves pupil participation in analyzing mathematical problems together with the story characters.
- 7) *Pupils' self-sufficiency* at different stages of mathematical studies. The texts give readers a chance to move forward for a while, letting them acquire an amount of knowledge on their own. They also use the method of speaking to the reader to cause pupils to act independently. Gradually, pupils begin to set themselves learning goals independently and are encouraged to produce their own educational texts.
- 8) *Customizing training* for different levels of competence and learning styles is achieved by presenting teaching material in different ways while taking individual learning appetites and preferences into account. DET texts offer pupils a choice of how they want to learn, be it through play, performance, research, projects or creation. They can also choose the difficulty level of the material they want to learn and what tasks they want to perform to test their knowledge. The versatile structure of the DET teaching-aid sets respects pupils' personal learning needs and preferences and allows them to choose a customized learning trajectory.
- 9) *Reliance on personal experience* takes students' everyday impressions and knowledge into account and their readiness to trust their intuitive judgment when analyzing information during theoretical learning and problem solving. In particular, certain DET texts provide practical information designed to stimulate pupils' interests in everyday applications of mathematics while demonstrating the role of mathematics in real life.
- 10) *Controlling the learning dynamics.* DET texts provide materials for routine progress checks, such as tasks of varying complexities (Levels I, II and III),

three test options depending on the preferred control method (calculation, proving, writing a story with examples), and self-check sections.

- 11) *Psychologically comfortable conditions for intellectual activity.* When conditions for intellectual activity are comfortable from the psychological perspective, they promote enjoyable and interesting learning and help each pupil feel that his learning efforts are effective. Narrative texts, for example, involve book characters who are known to pupils and support pupils emotionally with learning-related and personality issues; most importantly, they encourage pupils who had difficulties studying mathematics in primary school.

It is important to note that the psychodidactic approach does not merely improve the quality of learning and promote intellectual development; it also helps to establish a positive attitude towards a school subject. The approach is especially relevant for mathematics. There are data suggesting that children can experience a fear of mathematics that translates into a negative attitude towards the mathematics teacher (Picker and Berry 2001).

Here is an example of a development-focused educational text from the year 8 textbook. It includes types of text such as “*problematization*”, “*finding a formula*”, “*drafting definitions*”, and “*searching for and generalizing regularities*” (Gelfman et al. 2013, p. 114-115).

“§25. Studying the connection between roots and coefficients in a quadratic equation. Vieta’s theorem.

You have probably already noticed that the information about the nature of the roots in a quadratic equation is hidden in its coefficients. This is no longer a secret for us.

Whether a quadratic equation has any roots or not depends on the sign of the discriminant, which is a function of the equation’s coefficients.

An equation can be solved using a formula that includes its coefficients.

In what other ways are the roots and coefficients of quadratic equations connected? In order to understand these connections, it is useful to study how coefficients and roots in different equations behave.

Task 1. Solve the quadratic equations:

a)  $x^2 + 5x + 6 = 0$ ;      b)  $x^2 - 5x + 6 = 0$ .

What relations have you noticed between the roots and coefficients of these equations?

Are your conclusions correct for the equations below?

c)  $x^2 - 7x + 6 = 0$       d)  $x^2 + 7x + 6 = 0$ ;

e)  $x^2 + 6x + 8 = 0$ ;      f)  $x^2 - x - 6 = 0$ ?

Please try to formulate your conclusions and write them down algebraically.

When trying to find regular patterns, scholars often record their observations in tables, making it easier to discover such patterns. We recommend you to complete such a table too.

No.	Equation	$P$	$q$	$x_1$	$x_2$	$x_1 + x_2$	$x_1 \cdot x_2$
1	$x^2 + 5x + 6 = 0$	5	6	-2	-3	-5	6
2	$x^2 - 5x + 6 = 0$						
3	$x^2 - 7x + 6 = 0$						
4	$x^2 + 7x + 6 = 0$						
5	$x^2 + 6x + 8 = 0$						
6	$x^2 - x - 6 = 0$						
7	$x^2 + px + q = 0$						

Has the table helped you to understand the connection between the roots and coefficients of quadratic equations?

Compare your own conclusions with the ones provided in the textbook.”

Therefore, the educational text above is aimed at enriching pupils' conceptual experience. It encourages pupils to recognize a problem, independently analyze the provided equations and generally define the substantial patterns and connections between mathematical objects (the coefficients and roots of a reduced quadratic equation).

DET technology, which is used to develop different types of educational textbooks taking into account the training requirements for the psychodidactic texts, is implemented in the educational project “Mathematics. Psychology. Intelligence” (MPI). The development-focused educational texts are presented in the form of a training package (or educational-methodical complex):

- Set for school years 5 and 6: textbooks, story-based teaching books, problem books, self-study workbooks, electronic materials (exercises, tests, cartoons, mathematics games, electronic guide), course program and training manual for the teacher;
- Set for school years 7, 8 and 9: textbooks, problem books, course program and training manual for the teacher.

Teaching mathematics in grades 5 to 9 according to the MPI training package has been carried out in schools in different Russian cities over past 10 years.

Our studies use psychodiagnostic techniques—in comparison to the remedial, traditional and enriching models—and show that systematic work with developing educational texts in studying mathematics (enriched learning model) leads to increased productivity of intellectual activity. An increase in intelligence and creativity is observed from grades 5 to 9. Field-independent, reflective, fast, accurate, and categorical strategies of information processing increase (in terms of indicators of cognitive styles of field dependence/field independence, impulsivity/reflectivity, narrow/wide range of equivalence) (Budrina 2009, 2010). Remarkably, through the enriching learning models, students show significant cumulative growth in the convergent, divergent and style properties of intelligence, which are most pronounced starting from grade 8 (in comparison with the traditional model).

## Conclusion

DET Technology provides a tool that encourages pupils' intellectual development by offering a set of development-focused educational texts on a variety of topics within a school mathematics course. Such texts facilitate the enrichment of the main components in pupils' mental experience and make it possible to customize teaching.

The use of special-purpose educational texts based on the psychodidactic approach to teaching promotes the development of intellectual resources that are instrumental in achieving successful school learning.

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## **The relation between college students' academic mindsets and their persistence during math problem solving**

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The present study examined the extent to which college students' academic mindsets predicted their persistence when solving challenging math problems. The study included an experimental manipulation, in which participants initially received either an easy or a difficult arithmetic task. Following the manipulation, all participants solved two target math problems: one that was solvable but very hard and another that was unsolvable. Time spent attempting to solve each problem served as a measure of persistence. Results showed the predicted pattern for the solvable target problem, but not for the unsolvable problem. That is, for the solvable problem, the more of a fixed mindset participants had, the less persistent they were after completing a relatively difficult arithmetic task than after completing an easy task. The results suggest that, for certain types of math problems, students' persistence may vary as a function of academic mindset and previous experiences of math success or failure.

**Keywords:** math problem solving, academic mindset, math persistence, math confidence, college students

### **Introduction**

#### ***The relation between college students' academic mindsets and their persistence during math problem solving***

In modern society, where progress largely depends on advances in science and technology, achieving high levels of math understanding and problem-solving skills provides a foundation for both educational and professional success. Conversely, low levels of math achievement in college have been shown to impose constraints on students' career options (e.g., Shapka, Domene, & Keating, 2006). Thus, in order to optimize educational and professional outcomes, it is critical that we gain a better understanding of why some students perform worse than others in this fundamental area of knowledge.

In order to explain the origin of individual differences in math problem solving, researchers have carried out investigations from multiple perspectives. Some stud-

ies have focused on variability in cognitive capacity, identifying working memory, attention skills, and other executive functions as correlates of math performance (e.g., Mazzocco & Kover, 2007; McClelland, Cameron, Connor, Farris, Jewkes, & Morrison, 2007; Swanson & Beebe-Frankenberger, 2004). Other studies have examined variability in math strategy instruction, providing evidence that the use of advanced strategies is associated with greater accuracy in math problem solving (e.g., Crosnoe et al., 2010; Vasilyeva, Laski, & Shen, 2015). However, even when controlling for such cognitive factors, differences in math performance still emerge (e.g., Heaven & Ciarrochi, 2012). This has led researchers to search for emotional and motivational factors that can potentially explain why students with similar levels of working memory and knowledge of advanced strategies sometimes exhibit different levels of math performance (Covington, 2000; Meece, Anderman, & Anderman, 2006; Steinmayr & Spinath, 2009).

### ***Differences in motivation and persistence***

Existing studies have documented a relation between various components of motivation and students' math achievement across levels of education. For example, researchers examined a nationally-representative U.S. sample of middle-school students and found that achievement motivation and attitudes towards math were both directly and indirectly related to math grades (Singh, Granville, & Dika, 2002). Other scholars examined high-school students and reported that, controlling for intelligence and prior grades, students' attitudes towards math, achievement motives, and goal orientations all predicted subsequent math performance (Steinmayr & Spinath, 2009). Hackett (1985) tested college students and found that certain aspects of motivation, such as self-efficacy, predicted students' achievement in math courses, as well as their choice of a math-related major. However, it should be noted that most of these studies examined the effect of motivation on broad measures of math achievement, such as grades and standardized test scores. Relatively few studies have directly investigated the effect of motivation on specific math problem-solving behaviors that may account for broad differences in achievement.

One particular problem-solving behavior that is likely to be influenced by motivational factors is persistence, or students' willingness to stay on task even if it requires substantial time and effort to complete. Studies have shown striking differences among students on this characteristic, especially when it comes to math content (e.g., Fredricks, Blumenfeld, & Paris, 2004; Miller, Greene, Montalvo, Ravindran, & Nichols 1996). When solving a challenging math problem, some students do not stop trying until they find the solution, whereas others decide to move on to the next task after one or two attempts. Differences in persistence patterns during problem solving may help to explain why students with similar levels of intelligence and instructional input may end up with different educational outcomes (Hardre & Reeve, 2003). But, what explains persistence? Why do some students persist longer on challenging math problems than others? In the present study, we attempt to address this question by examining the relation between students' "academic mindsets" (their beliefs about the nature of intelligence) and their persistence.

***Predicting persistence: The role of academic mindset***

The concept of academic mindset refers to people's beliefs about whether intelligence can be changed (Dweck, 1999). According to Dweck, there are two basic mindsets regarding intelligence: People with a "fixed" mindset view intelligence as a personal trait that cannot be changed, whereas people with a "growth" mindset view intelligence as a malleable characteristic that can be improved with effort. To be clear, even though the terms "growth" and "fixed" mindsets suggest a dichotomous construct, they are typically measured on a continuum, such that individuals can hold relatively stronger or weaker versions of each mindset. For simplicity of presentation, we will use these terms to refer to individuals who are closer to one end of the continuum than the other.

Individuals who hold these different views tend to behave in different ways when presented with challenging tasks (Hong, Chiu, Dweck, Lin, & Wan, 1999). In particular, when people with a fixed mindset experience difficulty completing an academic task or receive negative feedback about their performance, they interpret this experience as an indication that they lack the intelligence or ability needed to be successful. And, because they believe that this low level of intelligence is fixed, they are likely to conclude that continuing to work hard will only lead to further embarrassment or will be a waste of their time. In contrast, those who hold a growth mindset tend to interpret the experience of difficulty or negative feedback as a sign that they may need to work even harder. The more time and effort they spend, the more their intelligence or ability will improve. Consequently, people with a growth mindset are more likely than people with a fixed mindset to persist at challenging tasks.

Several studies have investigated this proposed relation between mindsets and persistence. For instance, Hong and colleagues (Hong et al., 1999; Study 3) used fake scientific articles to temporarily shift participants' beliefs toward either the fixed or the growth end of the mindset continuum and then had participants complete problems from an intelligence test. After the test, half of the participants were told that they had performed well (66<sup>th</sup> percentile), while the other half were told that they had performed poorly (20<sup>th</sup> percentile). Participants were then asked whether they would like to engage in a tutorial exercise that had been shown to improve performance on the test or in an unrelated ability task. Choosing to work on the tutorial exercise could be construed as a sign of task persistence. The results showed that most participants who were shifted toward a growth mindset chose to engage in the tutorial exercise (73.3%), regardless of what kind of performance feedback they received. In contrast, participants who were shifted toward a fixed mindset were much less likely to engage in the tutorial task after receiving negative feedback (13.3%) than after receiving positive feedback (66.7%).

Another study (Liu, Chiu, Chen, & Lin, 2014) employed a correlational design, in which high-school students completed questionnaires measuring their academic mindsets, as well as their general willingness to confront challenges. The results showed that participants with a growth mindset reported stronger challenge-confronting tendencies. In addition, O'Shea and colleagues (O'Shea, Cleary, & Breen, 2010) conducted a study exploring the relation between goal-orientation, self-confidence, academic mindsets and persistence on math tasks. They measured aca-

demic mindsets using a mix of math-specific and more general items and measured persistence in terms of participants' self-reported preference for challenging math tasks, as well as their willingness to work hard on such tasks. The results showed that the more the students endorsed a growth mindset, the more they reported persisting on challenging math tasks.

In addition to measuring self-reported task preferences and levels of effort, studies of academic mindsets have also measured persistence in terms of students' *actual* behavior. Heine and colleagues (2001) conducted a cross-cultural study of mindsets that used a similar paradigm as Hong et al. (1999), except that (a) they measured college students' more general mindsets regarding personality as opposed to more specific mindsets regarding intelligence (e.g., "Everyone is a certain kind of person and there is not much that can be done to really change that") and (b) they measured persistence in terms of how much time participants spent completing a similar task after receiving success or failure feedback on the original task. The results showed that, for both American and Japanese participants, there was no association between mindsets and persistence after success feedback, but that the more the students endorsed a growth mindset, the more they persisted after receiving failure feedback.

Finally, in a study by Cury and colleagues (Cury, Fonseca, Zahn, & Elliot, 2008), younger participants (age 13–15) received success or failure feedback after completing items from an IQ test. They were then experimentally shifted toward a growth or fixed mindset regarding their ability being measured by the test. Before being given a second opportunity to complete the test, they were given an opportunity to practice for five minutes. Persistence was measured in terms of how much of the five minutes the participants spent practicing. The results showed that participants in the fixed mindset condition spent less time practicing and performed worse on the subsequent test than participants in the growth mindset condition.

In sum, there are several studies that examined the relation between academic mindsets and persistence in non-math domains using behavioral measures of persistence, and at least one study that investigated this relation in the math domain, although using self-report measures. To the best of our knowledge, there have been no published studies examining the relation between academic mindsets and actual behavioral persistence within the domain of math problem solving. This is the focus of the present study.

### ***The present study***

In this study, we examined the extent to which college students' academic mindsets predicted their persistence when solving challenging math problems. As noted earlier, academic mindsets should be particularly predictive of persistence when individuals are responding to challenge or negative feedback. In order to induce different levels of challenge, we experimentally manipulated the difficulty of an initial set of math problems that the students completed prior to being presented with the target problems. In one condition (Low Challenge), participants had to solve simple addition problems, and in the other condition (High Challenge), they had to solve more difficult multiplication problems in a limited amount of time.

After completing the challenge manipulation, participants were asked to solve two target problems. Some researchers may attempt to measure persistence in terms of the total time students spend completing a large number of problems that can be solved without too much difficulty. However, this way of measuring persistence is problematic because more competent individuals may find solutions more quickly than less competent individuals, and thus appear to be less persistent even though they are just as motivated to successfully complete the task. A partial solution to this problem involves presenting participants with extremely challenging (and perhaps even unsolvable) problems that require substantial time and effort even from highly competent individuals. Thus, we conducted pilot work to identify two problems that satisfied this criterion. Both problems utilized mathematical concepts that are typically acquired in middle school. Yet, their difficulty was high: One of them could not be solved in principle and the other was a solvable problem, which required multiple steps, as well as insight, to arrive at a solution. In fact, none of our pilot subjects (who were drawn from the same pool as study participants) could solve this problem.

Based on previous findings from the academic mindset literature (reviewed above), we expected students with a fixed mindset to spend less time solving the target math problems (i.e., not to persist as long) after completing a challenging math task (High Challenge condition) than after completing a relatively easy math task (Low Challenge condition). In contrast, we did *not* expect participants with a growth mindset to persist less in the High Challenge condition; if anything, we expected them to persist longer after completing a challenging task.

## Method

The current study was part of a larger project that collected participants' data on multiple measures. Here we focus only on those measures that were relevant to our research question and on the participants who completed all these measures.

### *Participants*

A total of 188 participants completed the first part of the study. Of these, 48 either did not complete the second part or completed a previous version of the second part with different target problems. Two additional participants did not complete the primary independent measure (of academic mindsets), and one participant was missing data due to computer error. The final sample included 137 college students, majoring in education or psychology, from a private research university in Massachusetts. The students were given a course credit for their participation. Among the 137 participants, 83% were female students, reflecting the gender composition of their respective departments. The age of participants varied between 18 to 24 years, with a mean age of 19. The majority of the participants were European-American (71%) and the rest were African-American, Asian-American, Hispanic-American or multiracial.



## Materials

**Theory of intelligence questionnaire.** We used Dweck's Implicit Theory of Intelligence Questionnaire (Dweck, 1999) to measure academic mindsets. It included eight items describing intelligence as being fixed (e.g., "You can learn new things, but you can't really change your basic intelligence") or malleable (e.g., "You can always substantially change how intelligent you are"). Participants read each statement and indicated their level of agreement on a 6-point scale (1 = "strongly disagree" to 6 = "strongly agree"). To arrive at a score for each participant, we first reverse-coded the items reflecting a growth-oriented view of intelligence so that higher scores reflected a greater tendency towards a fixed mindset. Then we averaged the participant's ratings across the eight items. To prepare the scores for statistical analysis, we standardized them relative to the midpoint (by subtracting the midpoint value of 3.5 from a given score and dividing the result by the standard deviation of the sample). Thus, we created an index of the participants' academic mindsets, with positive values suggesting a fixed mindset and negative value suggesting a growth mindset. The reliability of the mindset scale in our study was high (Cronbach's  $\alpha = .93$ ).

**Challenge manipulation task.** We created two sets of arithmetic problems that varied in difficulty so as to induce divergent effort experiences. Materials for the Low Challenge condition included three double-digit addition problems (e.g.,  $58 + 34$ ), while materials for the High Challenge condition included six double-digit multiplication problems (e.g.,  $18 \times 16$ ). Participants were instructed to complete these problems mentally (i.e., without paper, pencil, or calculator) and were given 4 minutes to do so. The relative difficulty of each condition, which was initially based on logical considerations, was supported by our pilot data.

**Challenge manipulation check.** After completing the math persistence task, participants answered two questions about the amount of effort and the difficulty level they experienced when solving the mental arithmetic problems during the effort manipulation task, as well as two questions about the amount of effort and the difficulty level they experienced during the math persistence task: "How much effort did you put into solving the initial set of arithmetic problems [the second set of math problems]?" (1 = "no effort" to 7 = "a lot of effort") and "How difficult was it for you to solve the initial set of arithmetic problems [the second set of math problems]?" (1 = "not at all difficult" to 7 = "very difficult"). Even though we had pilot data differentiating the two experimental conditions, we used this measure to check whether our participants indeed had a different effort experience and whether these differences were consistent with our expectations.

**Math confidence measure.** After completing the challenge manipulation, and again after completing the math persistence task, participants answered two questions about their math ability: "How good are you at solving math problems?" (1 = "not at all good" to 7 = "very good") and "How confident are you in your math ability?" (1 = "not at all confident" to 7 = "very confident"). The initial administration of this measure was meant to examine the extent to which participants called into question their math ability after completing the multiplication problems in the High Challenge condition, compared to the easier addition problems in the Low Challenge condition. Prior research (see Muenks & Miele, 2016) suggests that

individuals with a fixed mindset are more likely than individuals with a growth mindset to perceive a negative relation between effort and ability. Thus, it was possible that participants with a fixed mindset would report less confidence in their math ability in the High Challenge condition than in the Low Challenge condition, whereas participants with a growth mindset would be equally confident across the two conditions, or perhaps more confident in the High Challenge condition (if they perceived their hard work as improving their math ability). On the other hand, if participants' experience of the High Challenge condition was marked by failure, it is possible that all participants (regardless of mindset) would call their math ability into question and express low confidence.

**Math persistence task.** This task consisted of two math problems (see Appendix), which were selected through intensive piloting, and were found to be challenging. As noted earlier, one of the problems had a solution and the other one was unsolvable. We included an unsolvable problem so that participants could spend as much time as they wanted to devote to that problem without finding a solution. The amount of time participants spent on each problem was used as the measure of persistence.

**Demographic questionnaire.** A brief questionnaire was used to collect information about demographic characteristics of our sample, including gender, age, and ethnic background.

### ***Procedure***

Participants took part in two testing sessions, which were conducted an average of 15.7 days apart ( $SD=3.7$ ; range: 10 to 33 days). All tasks in both sessions were administered on computers, using Qualtrics Survey Software, by trained research assistants. In Session 1, participants finished a battery of self-report measures, including the theory of intelligence questionnaire. The entire battery took about 15 minutes to finish.

Session 2 included an effort manipulation task and a math persistence task. As part of the effort manipulation task, participants were randomly assigned to either the Low Challenge or High Challenge condition. In both conditions, they were given 4 minutes to solve mental arithmetic problems. If participants finished earlier, they could move on by clicking on the "Continue" button. If they were still working after 4 minutes had passed, the program automatically advanced them to the next screen.

Following the effort manipulation, participants from both conditions answered the first set of math confidence questions. They then took part in the same math persistence task, which involved solving two math problems, presented in a counterbalanced order. They were informed that they could stop and move on to the next problem at any point, but would not be able to click back from the second problem to the first problem. Participants were given 16 minutes to solve each problem, though they were not informed about this time limit. If participants were still working on a problem at the end of the 16-minute period, the program automatically advanced them to the next screen. After attempting to solve each problem, participants were given two minutes to explain their solution.

When students were done with the math problems, they were presented with the second set of math confidence questions, followed by the challenge manipulation check. Finally, they completed the demographic questionnaire. Session 2 lasted between 15 and 40 minutes, depending on how much time the participant spent on the math persistence task.

## **Results**

In analyzing the data, we first examined the results of the manipulation check to make sure that our experimental manipulation was effective at inducing different effort experiences in participants across the two conditions. Next, to test our key research hypotheses concerning the relation between academic mindsets and persistence, we conducted a series of ANCOVAs. We conducted ANCOVAs instead of linear regression analyses because some of our analyses included repeated measures; and ANCOVA, unlike regression, allowed us to examine the interaction between a continuous independent variable and a repeated measures factor without having to implement multi-level modeling.

The analyses that included a repeated measures factor (e.g., problem type) along with a continuous predictor (academic mindsets) were conducted in three steps (see Miele, Son, & Metcalfe, 2013). In Step 1, we conducted a mixed ANOVA with challenge condition as a between-subject factor and problem type as a repeated measure factor. In Step 2, we added the academic mindsets index in order to conduct a mixed ANCOVA. The main effect of problem type was reported from the first step in order to maximize power and to avoid scaling artifacts (see Algina, 1982; Thomas, 2009; Thomas et al., 2009). The main effects of challenge condition and academic mindsets, as well as all two- and three-way interactions, were reported from the second step. In Step 3, we carried out further analyses to explore any significant interactions between challenge condition and academic mindsets index. These simple-effect analyses estimated the effects of the challenge condition on persistence for participants who scored above (1.5 *SD*) and below (1.5 *SD*) the midpoint on the academic mindsets index (Aiken & West, 1991).

For analyses that did not include a repeated measures factor (e.g., analyses of time spent on the challenge manipulation task), we conducted one-step ANCOVAs. Note that because the academic mindsets index included in the ANCOVAs was midpoint centered, all main effects of the challenge condition, as well as all Challenge Condition  $\times$  Repeated Measure interactions, were estimated for participants who scored at the midpoint of the academic mindsets index, as opposed to participants who scored at the mean of the academic mindsets index. This scaling of the covariate can affect the significance of the challenge condition effects, particularly if the higher order interaction involving the academic mindsets index happens to be significant.

### ***Manipulation check***

To begin with, we analyzed participants' behavior on the math items in each condition of the challenge manipulation task. Participants in the Low Challenge condition were able to answer all problems in 4 minutes with 93% accuracy, whereas

participants in the High Challenge condition answered, on average, 75% of problems in the same time period, with only 33% accuracy on the problems answered and 23% accuracy overall. This suggests that many of the participants in the High Challenge condition did not have enough time to accurately complete all of the math problems they were assigned. To formally examine differences in time spent solving problems, we submitted time to an ANCOVA, with Challenge Condition as a between-subjects factor and Academic Mindset as a continuous covariate predictor<sup>1</sup>. The results of this analysis revealed a main effect of challenge condition: participants spent more time in the High Challenge condition than in the Low Challenge condition,  $F(1,133)=285.02$ ,  $p<.001$ ,  $\eta_p^2=.68$ . There was no main effect of Academic Mindset, nor was there a Challenge Condition  $\times$  Academic Mindset interaction ( $p$ 's  $>.23$ ).

In addition to analyzing participants' actual behavior and performance on the math items, we examined their subjective responses to the two questions concerning the amount of effort they expended and the amount of difficulty they experienced. We submitted responses to each question to a 2 (Task Focus: Challenge Task vs. Persistence Task)  $\times$  2 (Challenge Condition: Low Challenge vs. High Challenge) mixed ANCOVA, with repeated measures on the first factor and the Academic Mindset index as a covariate. This allowed us to determine whether the challenge manipulation affected participants' perceptions of effort and difficulty on the initial challenge task, as well as whether this effect happened to carry over to participants' perceptions of effort and difficulty on the persistence task.

For the effort question, there were significant main effects of Task Focus,  $F(1,135)=35.25$ ,  $p<.001$ ,  $\eta_p^2=.21$ , and Challenge Condition,  $F(1,133)=5.56$ ,  $p=.02$ ,  $\eta_p^2=.04$ ; however, these effects were qualified by a significant Task Focus  $\times$  Challenge Condition interaction,  $F(1,133)=7.57$ ,  $p=.007$ ,  $\eta_p^2=.05$ . Additional simple effects analyses showed that, for the Challenge Task, participants reported expending significantly more effort in the High Challenge condition ( $M=4.76$ ,  $SE=.23$ ) than in the Low Challenge condition ( $M=3.71$ ,  $SE=.22$ ),  $t(133)=3.34$ ,  $p=.001$ .<sup>2</sup> However, for the Persistence Task, participants reported expending relatively high levels of effort in both conditions (High Challenge:  $M=5.39$ ,  $SE=.20$ ; Low Challenge:  $M=5.36$ ,  $SE=.19$ ),  $t(133)=.04$ ,  $p=.97$ . None of the effects involving academic mindsets as a predictor were significant ( $p$ 's  $>.29$ ).

The pattern of results was similar for the difficulty question: There were significant main effects of Task Focus,  $F(1,135)=101.04$ ,  $p<.001$ ,  $\eta_p^2=.43$ , and Challenge Condition,  $F(1,133)=26.72$ ,  $p<.001$ ,  $\eta_p^2=.17$ ; however, these effects were qualified by a significant Task Focus  $\times$  Challenge Condition interaction,  $F(1,133)=26.58$ ,  $p<.001$ ,  $\eta_p^2=.17$ . Additional simple effects analyses showed that, for the Challenge Task, participants reported experiencing significantly more difficulty in the High Challenge condition ( $M=5.61$ ,  $SE=.27$ ) than in the Low Challenge condition ( $M=3.42$ ,  $SE=.25$ ),  $t(133)=5.96$ ,  $p<.001$ . However, for the Persistence Task, par-

<sup>1</sup> Because the distribution of times exhibited both floor and ceiling effects (due to the relatively short time limit), it did not benefit from a square root transformation. Therefore, unlike our later analyses of time, we included the raw times in our analysis.

<sup>2</sup> We report estimated means and SEs based on the full ANCOVA model, controlling for academic mindsets at the midpoint of the scale.

ticipants reported experiencing relatively high levels of difficulty in both conditions (High Challenge:  $M = 6.31$ ,  $SE = .16$ ; Low Challenge:  $M = 6.16$ ,  $SE = .15$ ),  $t(133) = .69$ ,  $p = .49$ . None of the effects involving Academic Mindset as a predictor were significant ( $p$ 's  $> .14$ ).

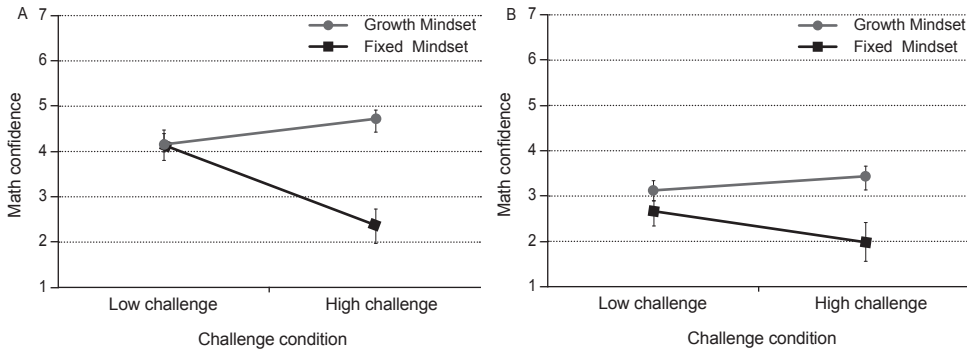
Together, findings from the behavioral and self-report analyses demonstrate that the manipulation task successfully induced divergent experiences of challenge in participants, and showed that this effect did not differ as a function of their academic mindset.

### ***Math confidence***

To examine how the challenge manipulation affected participants' math confidence, we submitted this measure to a 2 (Time Point: After Challenge manipulation vs. After Persistence Task)  $\times$  2 (Challenge Condition: Low Challenge vs. High Challenge) mixed ANCOVA, with repeated measures on the first factor and Academic Mindset as a covariate. The results of the analysis revealed significant main effects of Time Point,  $F(1,135) = 110.20$ ,  $p < .001$ ,  $\eta_p^2 = .45$ , and Academic Mindset,  $F(1,133) = 9.77$ ,  $p = .002$ ,  $\eta_p^2 = .07$ , as well as a marginal effect of Challenge Condition,  $F(1,133) = 3.17$ ,  $p = .08$ ,  $\eta_p^2 = .02$ . The main effects were qualified by a significant Time Point  $\times$  Challenge Condition interaction,  $F(1,133) = 4.38$ ,  $p = .04$ ,  $\eta_p^2 = .03$ , and a Challenge Condition  $\times$  Academic Mindset interaction,  $F(1,133) = 5.98$ ,  $p = .02$ ,  $\eta_p^2 = .04$  (but not a Time Point  $\times$  Challenge Condition interaction,  $p = .38$ ). The two-way interactions were in turn qualified by a significant Time Point  $\times$  Challenge Condition  $\times$  Academic Mindset interaction,  $F(1,133) = 5.39$ ,  $p = .02$ ,  $\eta_p^2 = .04$ .

The nature of the three-way interaction suggested that the effects of challenge condition and participants' academic mindsets on math persistence varied by time point. To explore this possibility, we conducted separate follow-up analyses for each time point, with Challenge Condition as a between-subject variable and Academic Mindset as a covariate. For the first time point (immediately after the challenge manipulation), there were significant main effects of Challenge Condition,  $F(1,133) = 6.61$ ,  $p = .01$ ,  $\eta_p^2 = .05$ , and Academic Mindset,  $F(1,133) = 11.34$ ,  $p < .001$ ,  $\eta_p^2 = .08$ , which were qualified by a significant Challenge Condition  $\times$  Academic Mindset interaction,  $F(1,133) = 10.91$ ,  $p = .001$ ,  $\eta_p^2 = .08$ . However, for the second time point (immediately after the persistence task), there was a main effect of Academic Mindset,  $F(1,133) = 5.87$ ,  $p = .02$ ,  $\eta_p^2 = .04$ , but not effects of Challenge Condition and no Challenge Condition  $\times$  Academic Mindset interaction ( $p$ 's  $> .20$ ).

To explore the significant interaction for the first time point, we conducted additional simple slope analyses. As shown in Figure 1, one analysis estimated that participants with a growth mindset (1.5 *SD* below the midpoint of the academic mindsets scale) in the High Challenge condition were as confident as participants with a growth mindset in the Low Challenge condition,  $t(133) = 1.55$ ,  $p = .12$ . In contrast, participants with a fixed mindset (1.5 *SD* above the midpoint of the academic mindsets scale) in the High Challenge condition were significantly less confident than participants with a fixed mindset in the Low Challenge condition,  $t(133) = 3.50$ ,  $p < .001$ . Thus, it appears that the high levels of effort and difficulty briefly experienced by participants in the High Challenge condition during the challenge manipulation task led those with a fixed mindset, but not those with a



**Figure 1.** Math confidence by Challenge Condition and Academic Mindset, immediately after the challenge manipulation (A) and after the persistence task (B). Error bars indicate one standard error

growth mindset, to call their math ability into question. Interestingly, most participants (including those with a growth mindset) appeared to call their math ability into question after the longer and more challenging math persistence task, regardless of which version of the challenge task the student initially completed.

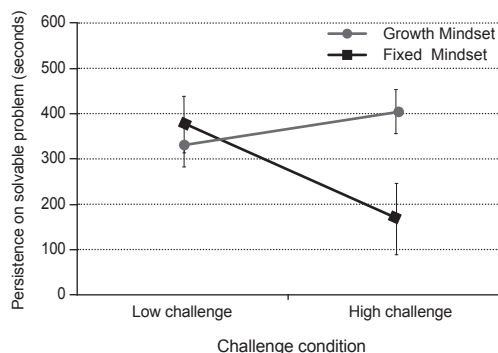
### Persistence

There was wide variability (from 20 seconds to 16 minutes) in the amount of time participants spent solving each of the two target problems. On average, they spent about 332 seconds ( $SD = 266.00$ ) working on the solvable problem and 437 seconds ( $SD = 290.46$ ) working on the unsolvable one. This variable was positively skewed: For both problems, most participants spent less than 400 seconds (73% for the solvable problem, and 54% for the unsolvable problem), but a few participants used the maximum amount of time that was allowed (8% for the solvable problem and 10% for the unsolvable problem). To address the issue of skewness, we carried out square-root transformations. For all subsequent analyses, we used the square-root transformed time as a persistence measure for both problems.

An analysis of problem-solving time yielded a significant main effect of Problem Type,  $F(1,135) = 19.52$ ,  $p < .001$ ,  $\eta_p^2 = .13$ , such that participants spent more time on the unsolvable problem than the solvable one. This main effect was qualified by a marginally significant Challenge Condition  $\times$  Problem Type interaction,  $F(1,133) = 2.84$ ,  $p = .09$ ,  $\eta_p^2 = .02$ , which was itself qualified by a marginally significant Challenge Condition  $\times$  Problem Type  $\times$  Academic Mindset interaction,  $F(1,133) = 3.55$ ,  $p = .06$ ,  $\eta_p^2 = .03$ . No other effects were significant ( $p$ 's  $> .23$ ).

The nature of the three-way interaction suggested that the effects of the challenge condition and participants' academic mindsets on math persistence varied for the solvable and unsolvable problem. To explore this possibility, we conducted separate follow-up analyses for each problem, with challenge condition as a between-subject variable and academic mindsets as a covariate. For the unsolvable problem, we found no main effects of Challenge Condition or Academic Mindset (all  $p$ 's  $> .51$ ), nor a significant interaction ( $p = .997$ ). The pattern of results for the solvable problem, however, was quite different. In particular, although neither





**Figure 2.** Persistence on solvable problem (in seconds) by Challenge Condition and Academic Mindsets. To make interpretation more straightforward, the figure depicts means that were estimated from a model that included untransformed persistence times, not the model reported in the results section. Error bars indicate one standard error

of the main effects were significant ( $p$ 's > .14), there was a significant Challenge Condition  $\times$  Academic Mindset interaction,  $F(1,133) = 4.00$ ,  $p < .05$ ,  $\eta_p^2 = .03$ .<sup>1</sup>

As shown in Figure 2, an additional simple-effects analysis estimated that participants with a growth mindset (1.5  $SD$  below the midpoint of the mindset scale) spent roughly equal amounts of time solving the math problem across the two challenge conditions,  $t(133) = 1.06$ ,  $p = .29$ . In contrast, another analysis estimated that participants with a fixed mindset (1.5  $SD$  above the midpoint of the mindset scale) spent significantly less time solving the math problem in High Challenge condition compared to the Low Challenge condition,  $t(133) = 2.04$ ,  $p = .04$ .<sup>2</sup>

It should be noted that, after conducting the analyses reported above, we conducted an additional set of analyses that included Problem Order (Solvable First vs.

<sup>1</sup> When initially analyzing the data, we applied a more conservative filter which excluded 7 participants who expressed suspicion that one or more of the problems was unsolvable, 4 participants who were particularly slow on the Low Challenge version of the manipulation task, and 2 participants who were particularly fast on the High Challenge version. We also excluded 1 participant who seemed to mistakenly think that the time allowed on the persistence task was only 4 minutes, 1 participant who expressed concern about being sick, and 1 participant who expressed concern about having a learning disability ( $N = 16$  in total). In the analysis of persistence, the three-way interaction was marginally significant ( $p = .06$ ), but the Challenge Condition  $\times$  Academic Mindset interaction for persistence on the solvable question was not significant ( $p = .12$ ) and the effect size was smaller than in the analysis reported above ( $\eta_p^2 = .02$ ).

<sup>2</sup> In addition to measuring participants' mindsets about intelligence using the standard Dweck measure, we also measured participants' specific beliefs about math ability using a 4-item measure we adapted from Kloosterman & Stage (1992). With this measure we found a marginal interaction of problem type and math beliefs on persistence,  $F(1,133) = 2.90$ ,  $p = .09$ ,  $\eta_p^2 = .02$ , but no effect of challenge condition. The interaction reflected the fact that there was a significant inverse correlation between math beliefs and persistence on the solvable problem ( $r = -.18$ ,  $p = .04$ ), but not the unsolvable problem ( $r = -.02$ ,  $p = .81$ ). It is unclear why the measure of math-specific beliefs (unlike the more general mindset measure) did not interact with the effort manipulation. Perhaps, because the math-specific measure contained items that focused more on the relation between effort and math ability, as opposed to the malleability or fixedness of ability, participants who were high on this measure (i.e., who believed that math ability could not be improved through effort) did not necessarily believe that high effort meant that they were low in ability.

Unsolvable First) as a factor. Although Problem Order did not significantly moderate the marginally significant three-way interaction ( $p = .11$ ), it did make the three-way interaction non-significant ( $p = .17$ ) when included. There was also a marginally significant Problem Order  $\times$  Problem Type interaction ( $p = .099$ ), as well as a significant Problem Order  $\times$  Challenge Condition interaction ( $p = .009$ ). To further explore these order effects, we conducted another analysis of the solvable problem, with Problem Order included. Although there was a marginally significant Problem Order  $\times$  Challenge Condition interaction ( $p = .07$ ), the Challenge Condition  $\times$  Academic Mindset interaction only dropped slightly in significance ( $p = .06$ ). Furthermore, this two-way interaction was not moderated by Problem Order ( $p = .75$ ). In contrast, a final analysis of the unsolvable problem did reveal a marginally significant Problem Order  $\times$  Challenge Condition  $\times$  Academic Mindset interaction ( $p = .06$ ), which qualified a significant Problem Order  $\times$  Challenge Condition interaction ( $p = .008$ ). Because we believe that there may have been issues with how participants interpreted the unsolvable problem (e.g., realizing that it was indeed unsolvable; see Discussion), we refrain from interpreting these interactions.

### **Mediation analysis**

To determine whether the interactive effect of Academic Mindset and Challenge Condition on persistence (for the solvable problem) was partly mediated by participants' math confidence after completing the challenge manipulation, we conducted a mediation analysis using the PROCESS bootstrapping procedure developed by Hayes (2013) and implemented as a macro in SPSS. We used Model #8 with 5,000 bootstrap resamples and specified the square-root transformed time for the solvable problem as the outcome variable (Y), Academic Mindset as the independent variable (X), Challenge Condition as the moderator (W), and Math Confidence after the challenge manipulation as the mediator (M). The confidence intervals ( $-1.71, -.19$ ) for the mean indirect effect of the Academic Mindset  $\times$  Challenge Condition interaction on persistence *through* Math Confidence ( $-.75$ ) did not include 0, indicating that the effect was significant at  $p < .05$  and providing evidence of mediation.

### **Discussion**

The key research question of the present study was whether students with different mindsets regarding the nature of intelligence tend to show different patterns of persistence when solving math problems. To activate the motivational consequences of holding a particular mindset, we presented one groups of participants with a set of difficult arithmetic problems that were meant to induce high levels of effort and difficulty. Their interpretation of this experience was expected to undermine persistence in students with a fixed mindset, but not in participants with a growth mindset. The remaining participants were presented with simple arithmetic problems, which were not meant to induce high levels of effort or difficulty, and thus were not expected to undermine the persistence of participants with a fixed mindset. Our findings provide support for the hypothesized relation, indicating that the more fixed the participants' mindset, the less persistence they exhibited in the High

Challenge condition compared to the Low Challenge condition. It is important to note, however, that this effect was qualified by the type of problem, such that the hypothesized relation was only observed in the case of a solvable math problem. It is also worth noting that the effect appears to have been partly mediated by changes in participants' math confidence. That is, participants with a fixed mindset were estimated to have substantially lower confidence in their math ability after completing the High Challenge version of the arithmetic than after completing the Low Challenge version; this lower confidence appears to have translated into less time spent on the solvable problem of the persistence task. Overall, our findings are consistent with previous research, and provide new evidence from the domain of math problem solving, suggesting that students' academic mindsets influence their interpretation of their math problem-solving experiences as well as their persistence on subsequent problem solving.

Although this is not an experimental study, it raises a possibility that shifting one's mindset may have beneficial effects on persistence in a math problem-solving context. Researchers have successfully manipulated participants' mindsets both temporarily and longitudinally and observed divergent patterns on behavior after this manipulation. For instance, some researchers have manipulated participants' mindsets temporarily by presenting them with articles arguing for either a fixed or growth mindset and shown that these mindsets can have a causal effect on participants' subsequent behavior or judgments across multiple domains (e.g., Aronson, Fried, & Good, 2002; Chiu, Hong, & Dweck, 1997; Hong et al., 1999; Levy, Stroessner, & Dweck, 1998; McConnell, 2001). In addition, mindset has been manipulated longitudinally. Blackwell and colleagues (Blackwell, Trzesniewski, & Dweck, 2007) developed an intervention for middle-school students and followed them over the course of a semester. Their results showed that those who received the mindset intervention not only expressed more of a growth mindset, but also exhibited higher achievement in math (see also Paunesku et al., 2015). These studies suggest that students' mindsets are amenable to intervention in classroom settings.

The malleability of academic mindsets points to an additional path for improving students' persistence, which both teachers and researchers identify as a critical aspect of student behavior during math problem solving. Thus, the current findings linking mindset and persistence in math problem solving have potentially important practical implications. In addition, they have theoretical implications: It is critical to create a comprehensive model of individual differences in math performance, and our findings add information about an important motivational component of this future model.

### ***Difference in the patterns observed with a solvable versus unsolvable problem***

We included an unsolvable problem in the current study so that students with high math skills would be given an opportunity to demonstrate the extent of their persistence without any limits imposed by their own ability to solve the problem quickly. Yet, there was also a possibility that particularly insightful students could see, after some initial attempts, that the problem could not be solved in principle, and thus quit trying for a reason other than a lack of persistence. Thus, we also in-

cluded a second — solvable — problem that was very challenging and unlikely to be solved in 16 minutes by most participants.

The study participants showed different patterns of performance on the two problems. First, they spent on average more time on the unsolvable problem, compared to the solvable one. This could partly be due to the difference in the nature of the problems. The solvable problem can be categorized as requiring an insight (see Appendix). It might have appeared to participants that some provisions were missing, making them feel that they were stuck in the middle of the problem-solving process, without a clue to figure their way out. Thus, they might have been particularly disposed to quit solving the problem. The unsolvable problem, on the other hand, was likely to elicit a trial-and-error approach, making participants feel that every time they crossed out an unsuitable answer, they were getting closer to the real solution. This sense of making progress might have helped participants stay engaged in the task for a longer time.

The second difference in students' performance on the two problems concerned the hypothesized interaction between the mindset and the challenge condition. Whereas the persistence times on the solvable problem revealed such an interaction, it was not observed in the case of the unsolvable problem. This finding was somewhat puzzling. One possibility is that some participants, including those with a growth mindset, after making a number of attempts to solve the problem, realized that it was unsolvable. Indeed, several study participants made an explicit comment that the problem had no solution (though some participants also said this about the solvable problem). After identifying the problem as unsolvable, these participants may have quit, but not because of a low level of persistence. Thus, the actual level of persistence, measured by the time spent on this problem, may have been confounded with the ability to recognize the problem as unsolvable. This, of course, is just one possible explanation of the lack of effects of mindset and challenge condition on the unsolvable problem. In future work, it would be useful to systematically vary this and other characteristics of the problem in order to determine whether some features of math problems moderate the relation between mindset and persistence on math problems.

### **Limitations and future directions**

One limitation of this study is that the relation between on-task persistence and math performance was not tested. A more comprehensive study is needed to explore the relation among academic mindsets, on-task persistence, and math problem-solving accuracy. For instance, on-task persistence may serve as a mediator of the effects of academic mindsets on math problem-solving accuracy, as well as long-term math achievement, thus explaining one potential mechanism for the effects observed in previous studies (e.g., Blackwell et al., 2007). Another limitation is that participants' academic mindsets were not manipulated, but measured as an individual difference variable. To draw a causal conclusion regarding the relation between academic mindsets and persistence, an experimental design that manipulates participants' mindsets is necessary. In particular, future work may include a design of an intervention study that targets students' mindsets and tracks longitudinally the effects of the intervention on students' persistence across multiple math tasks.

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## Appendix

### Math Persistence Task

#### Solvable problem

A car travels downhill at 72 mph (miles per hour), on the level at 63 mph, and uphill at only 56 mph. The car takes 4 hours to travel from town A to town B. The return trip takes 4 hours and 40 minutes.

Find the distance between the two towns.

*Solution:* Let the total distance travelled downhill, on the level, and uphill, on the outbound journey, be  $x$ ,  $y$ , and  $z$ , respectively.

The time taken to travel a distance  $s$  at speed  $v$  is  $s/v$ .

Hence, for the outbound journey

$$x/72 + y/63 + z/56 = 4$$

While for the return journey, which we assume to be along the same roads

$$x/56 + y/63 + z/72 = 14/3$$

Multiplying both equations by the least common multiple of denominators 56, 63, and 72, we obtain

$$7x + 8y + 9z = 4 \cdot 7 \cdot 8 \cdot 9$$

$$9x + 8y + 7z = (14/3) \cdot 7 \cdot 8 \cdot 9$$

Now it is clear that we should add the equations, yielding

$$16(x + y + z) = (26/3) \cdot 7 \cdot 8 \cdot 9$$

Therefore  $x + y + z = 273$ ; the distance between the two towns is 273 miles.

#### Unsolvable problem

Make 2 three-digit numbers using the following digits—1, 3, 4, 5, 6, 9—so that one of these three-digit numbers is exactly five times greater than the other (each digit should be used only once).

Enter your solution below and, on the next page, explain how you arrived at this solution.

*Solution:* Since one number has to be exactly five times greater than the other, the last digit of the bigger number has to be 0 or 5. However, 0 is not on the available digit list, so it has to be 5. Meanwhile, to make a three-digit number five times greater than the other, the hundreds place has to be 6, 7, 8 or 9. According to the given list, the possible bigger numbers would be  $9 \times 5$  and  $6 \times 5$ .

At the same time, the hundreds place of the smaller number has to be 1, to keep the bigger number three-digit, and the ones place of the smaller number has to be an odd number, making the only possible smaller numbers  $1 \times 3$ .

Thus, there are four possible pairs: 965 & 143, 945 & 163, 645 & 193, and 695 & 143. None of those bigger three-digit numbers is exactly five times greater than the smaller one, meaning that there is no solution to this problem.

## **Problem solution as a guided activity with Mexican schoolchildren**

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The goal of the present study was to describe the organization of a guided activity for problem solution in primary school. The method, which was applied to mathematical problems, allowed us to propose a specific orientation for the proper solution of arithmetic problems by pupils. The study was based on the activity-theory approach applied to the process of teaching and learning. It was carried out with pupils in the second grade of a private school in the city of Puebla (Mexico). The method was used in the classroom during 30 school sessions of 1 hour per day. The methodology of formative experiment was used in the study. Qualitative analysis of the pedagogical process of teaching and learning was conducted. The results show that, after participation in the formative process, the schoolchildren became able to identify essential elements, data, and all relationships among them in order to solve mathematical problems. At the end of the program the verbal external level was raised for the process of orientation and the solution of problems together with the ability to use logarithms independently. We conclude that orientation, as a guided form of activity in primary school, is essential for the development of the ability to analyze problems.

**Keywords:** problem solution, learning of mathematics, teaching methods, school age, orientation in mathematics, conceptual learning

### **Introduction**

In Mexico, the teaching of mathematics in primary school faces severe difficulties. The learning of school pupils is extremely poor. The results of national tests show that only 39.5% of the pupils in the sixth grade show a sufficient level of knowledge of mathematics (Planea, 2015). Similar results were obtained during the Second Regional Comparative and Explanatory Study of pupils in Mexico and other countries of Latin America: it was found that 30% of the children did not understand the meaning of the decimal system and were not able to perform elementary arithmetic operations (SERCE, 2009). Similar problems are typical also in other countries.

Spanish authors Vicente, Dooren, and Verschaffel (2008), while analyzing results from the OECD Programme for International Student Assessment (PISA), found that for Spanish pupils the worst results were obtained for problem solution. Such results indicate that the children need not only to memorize some kinds of knowledge but also to develop the ability to use concepts in problems with mathematical situations. The weak areas of teaching in primary school are instilling an understanding of the concept of number, an ability to execute operations, and the capability to solve problems.

The same kind of necessity for organized work with the content of concepts instead of isolated memorization and execution of operations has been claimed by representatives of the activity-theory approach (Galperin, 1959a/2011; Davidov, 1988; Ilienkov, 2009; Talizina, 2009). Nowadays, such work is still necessary within the teaching process and programs of education in many countries. The traditional way of organizing the teaching and learning process is no longer useful in the modern world. There are two main types of teaching and learning activity. The first one might be called the traditional education system, in which the empirical process of teaching and learning takes place without specific consideration of systems of knowledge and abilities to teach. The spontaneous acquisition of knowledge is the result of such a system with no gains in conceptual knowledge or with problem solution. Within this system of education, there are no clear goals for the formation of concepts. The goals are related only to concrete operations, which are limited to the accumulation of habits. The goal of teaching mathematics is to execute arithmetical operations and to memorize symbols from only a formal point of view. The basic method is repetition of enormous numbers of exercises of the same type (Ávila, 2006; Bermejo, 2008; Martín, 2003). Normally, this kind of teaching of mathematics is boring for children, and the results are extremely poor.

The second type of education is almost absent in official educational programs in Latin America, as in other countries, but it appears as a kind of innovative research program by psychologists and pedagogues in different contexts. Often, programs of this type are the results of experimental research initiated and directed by specialists in the sphere of education (Salmina, 2001; De Zubiría, 2006; Talizina, 2009; Solovieva & Quintanar, 2010; Solovieva, 2013; Solovieva, Lázaro, Rosas, Quintanar, Escotto, & Sánchez, 2014[]). Such programs are based on the so-called social-cultural approach directed by a constructivist perspective (Carretero & Castorina, 2012). In other studies, the research takes into account the systematic backgrounds of activity theory (Rosas, Solovieva, & Quintanar, 2014; Solovieva, Lázaro, & Quintanar, 2013; Solovieva, Ortiz, & Quintanar, 2010; Talizina, 2000; Zárraga, Quintanar, García, & Solovieva, 2012).

Special research has been carried out not only with the goal of assessment and confirmation of difficulties of pupils, but as a way of presenting knowledge within oriented actions in order to guarantee the successful formation of concepts (Nikola & Talizina, 2001; Salmina, 2001; Volodarskaya, 2001). Such methods for the initial formation of actions on a materialized level with posterior interiorization were proposed for the development of number-concept, decimal-system, and basic logic operations such as measuring, comparing, and converting (Salmina & Filimonova, 2010; Solovieva, Ortiz, & Quintanar, 2010; Solovieva, Rosas, & Quintanar, 2013;

Talizina, 2009; Zárraga, Quintanar, García, & Solovieva, 2012). In order to achieve positive acquisition of concepts and logical intellectual actions, the teacher needs to understand the structure of the content to be taught, the intellectual actions proposed for the children, and the organization of the gradual interiorization of the actions by stages: materialized, perceptual, verbal external, and verbal internal (Galperin, 1957; Álvarez & Del Río, 2013; Nikola & Talizina, 2001; Solovieva, 2013; Talizina, 2009).

In the case of problem solution, its content is not limited by the traditional topics taught in elementary mathematics. Nikola y Talizina (2001) has stressed that the content of problems involves the category of processes, which is never presented or explained to children. At the same time, problem solutions represent a kind of intellectual action, in which mathematical concepts and operations can actually be applied without memorization. This cognitive activity requires understanding not only the content of arithmetic but also the elements of a symbolic situation and the relations among these elements (Vicente et al., 2008). Children cannot understand these relationships spontaneously or individually but require specific, guided orientation (Galperin, 1959b/2011).

Traditional teaching usually does not present the content (internal image) of the problem situation but simply “asks” the final question of the problem. The question of the problem does not appear in the consciousness of the pupil as a mathematical question, which requires mathematical actions and solutions, but only as any kind of question in day-to-day life. In such a case no reflection or understanding takes place in the consciousness of the child. Children act in a chaotic, nonsequential, empirical way. Very often, teachers do not include problem solutions in the didactics precisely because of the impossibility of providing guided explanation and orientation during problem-solving. From the point of view of the reflexive organization of understanding, the child has to identify kinds of actions and their sequence according to the question of the problem (Nikola & Talizina, 2001). Memorization is not helpful in such cases. Conditions of the problem always describe some kind of situation, but children are unable to generalize the elements of the situation according to systemic mathematical concepts. The teacher has not only to announce the problem but also to provide the orientation of the analysis of the mathematical relations of the elements of the problem. Knowledge of the context of day-to-day life is not sufficient for this purpose, as constructivist methodology always claims (Carretero & Castorina, 2012). Specific kinds of intellectual actions are necessary as are operations with scientifically generalized concepts instead of concrete interpretation of the words of the problem (Talizina, 2009). The level of difficulty of the problem depends also on the logical structure of the problem (Rosales, Orrantia, Vicente, & Chamoso, 2008).

Each arithmetic problem has a final question, where the answer represents the goal of the problem. To answer this question (or a sequence of questions) it is necessary to accomplish reflexive analysis of the data and conditions in order to obtain necessary and sufficient information about mathematical relationships and logic formulas. Mathematical relations are not equal to contextual day-to-day relationships. This point is never explained to children, at least in the traditional way of teaching in Mexico. The consequence is that the pupils, in the best cases, deal with

the concrete words of the text of the problem and not with the mathematical and logic content of the problem. In the worst cases, children are unable to understand even the concrete texts of the problem. This is another huge problem for teaching and learning progress. The methodology of the teaching of language and the work with texts and comprehension in primary school should be essentially modified (Solovieva, Lázaro, Rosas, Quintanar, Escotto, & Sánchez, 2014; Solovieva, 2013; Solovieva & Quintanar, 2010). We are convinced of the strong relationship between the capacity to solve problems in mathematics and the successful acquisition of linguistic abilities by children.

In order for children to operate correctly with the data in problems, it is necessary to provide an orientation attitude and oriented activity in respect to the mathematical content. Such a point of view does not appear naturally and spontaneously, as constructivism might claim. Constant assessment of children's abilities does not help in understanding their difficulties. Only a formative process provides an essential and general understanding of the way that children learn at school (Galperin, 1959a/2011). Oriented activity is a functional part of children's intellectual activity in general, which needs to be formed with specific content (Galperin, 1957/2011). Only with the help of the data of oriented activity, instead of passive perception and repetition of the verbal part of the problem, can a child create a general scheme for solving problems of the same kind and only for each concrete problem. Only after such oriented activity is it possible to pass on to the search for arithmetic operations (Luria, 1980; Tsvetkova, 1999). As for problem solution, it is necessary to work with the process of orientation before passing on to the realization of operations.

The traditional way of teaching mathematics starts and finishes with arithmetic operations. Our essential interest was to show a way of creating and applying the methodology of the analysis of teaching and learning activity in the real context of the day-to-day teaching of mathematics in a small private school. The goal of our research was to show the possibility of using this methodology as a unique process. Such analysis of the activity of problem solution permitted us to propose content for guided orientation and for steps to problem solution with the group of Mexican schoolchildren.

Our study included descriptive and qualitative research, which assumed that teaching is a process of the formation of learning. The methodological and theoretical background of our research was the theory of the learning process as a divided and shared activity between teacher and pupils (Leontiev, 2003; Talizina, 2000, 2009) together with a psychological conception of the formation of mental concepts by steps (Galperin, 1959a/2011, 1957/2011). According to activity-theory methodology, it is possible to have a directed and oriented model of teaching with the conscious and reflective participation of children in the process of solving mathematical problems. In our research, the children became active participants in this process. Collective forms of guided activity were proposed for orientation toward and solution of problems. The whole content of knowledge was systematized according to the identification of general initial concepts (the problem and its elements) and of the essential kinds of intellectual actions with numbers in which such concepts might be included (Davidov, 1996).



## Method

### *Participants*

The participants of the study were pupils in the second grade of a private primary school in the city of Puebla, Mexico. They had medium-low social living conditions. The class included four regular pupils with an average age of 7.25 years. The children had no clinical history and had never repeated a grade. All pupils showed sufficient abilities in reading and writing and presented no learning disabilities. An understanding of number concepts and elementary arithmetic operations were the prerequisites that had been established previously. All the children took part in most of the formative sessions, and none ever lost more than three consecutive sessions.

### *Formative process*

The formative process was used to organize the teaching. We understand such an experiment as a continuation of the genetic causal method proposed by Vygotsky and developed afterward by his followers (Leontiev, 2003). The formative process consists in the organization of the qualitative interaction between the experimenter and the participants. This interaction is not of a spontaneous nature; all levels and types of interaction are previously planned. The plan of action corresponds to the necessities of formation in the stages of the methodology (Galperin, 1959a,b/2011, 1957/2011) and to the content of the problem-solving activity.

At the same time, the concrete forms of communication among the teaching and learning processes are dynamic interactions that provide shared, guided activity within the dialogical involvement of all participants in the joint activity. The formative process always takes into consideration parameters established according to the goals of formation and the concrete necessities of real educational practice (Leontiev, 2003). The experimenter has to know perfectly the content, the structure, and the features of the activity, which are being formed in participants (Solovieva, 2013; Nikola & Talizina, 2001; Talizina, 2000).

Qualitative analysis of the obtained data and of the teaching process was accomplished during and after the research. The initial and final assessments of the children's activity were made on the bases of the structure of problem-solving activity. Such elements were identification of final and sequential questions, steps, the unit of measurement and conversation of data, operations. Specific difficulties and mistakes were analyzed and quantified for each element before and after the formative experiment.

### *Formative program*

The goal of the program was to provide orientation for the intellectual activity of problem solution in collaboration with an adult and other children. For this purpose, problem solution was divided into a sequence of external, collective intellectual actions that helped to solve the problems and to answer the final questions. The intellectual actions of the program were completed at perceptive and verbal external levels, according to the conception of the formation of mental actions by stages

(Galperin, 1998). The program was carried during 30 collective classes of 1 hour each when the college was in session and included a total of 344 simple and complex mathematical problems. The program included the following general stages:

1. Presentation of orientation for the process of problem solution, discussion of the contents of the problems, differentiation of the verbal and numeric aspects of the problems, identification of the steps for solution and elaboration of orientation cards for the steps.
2. Solution of simple problems with the help of orientation cards. Explanation of sufficient data, relevant and irrelevant data, and insufficient data for answering the final question.
3. Solution of complex problems with the help of orientation cards. Identification of sequential questions. Explanation of the necessity to convert units of measurement to only one unit according to the question. Reflection of the impossibility of numeric operations if the unit of measurement is not the same according to the verbal content of the problems.
4. Creation of own problems in groups. Exchange of the problems for independent solution.

### ***Content of the formative program***

Before starting with solution of the problems, some exercises with accessible verbal content were designed for the children. The problems were presented according to level of difficulty (Luria & Tsvetkova, 1966/1981) and started from simple problems (only one operation involved) to more complex (more than one operation involved) (Table 1).

**Table 1.** Examples of problems used during the teaching process

Simple problem	Complex problem
"Our library . . . has 40 books divided among 5 stands. If the teacher . . . puts the same quantity of books on each stand, how many books will we have on each stand?"	"Renata and Daniel went to the market and bought 2 kilos of apples, 300 grams of sugar, and 1 kilo of pasta. How many grams did they buy altogether?"

These examples show that the verbal structure of simple problems is not necessarily also simple. We tried to show that the word *simple* might be used equally for mathematical content and for verbal content of the text of the problem. Within the content of the program, different verbal content was used for working with the same type of mathematical structure: one operation or more than one operation.

Afterward, the general orientation for problem solution was presented to the children. It was explained to them that the problems always involve a day-to-day, ordinary situation. The logic of mathematical solution does not depend on using all presented words, subjects, and objects within the text of the problems. Success

in solving the problems depends on the possibility of substituting one or more arithmetical (mathematical) operations for part of the descriptions. If it is possible to make such a substitution, a problem might be resolved. If not, the problem might not be resolvable in arithmetical terms. Important concepts in this situation are the concepts of number and of the decimal system. Without such concepts it is impossible to solve the problems or to execute arithmetic operations. Memorization of some data is not specifically useful for solving the problems. Each problem requires analysis of the content. It was explained to the children that the problem pretends not to present all data so that the subject needs to search for some of them. The objective is to answer the final question (series of questions) of the problem. In order to find the answer, it is necessary to follow some steps. Children received orientation cards in order to obtain these steps (Figure 1). The card was always designed together with the children in the group and the steps were discussed reflexively. Each participant had his/her own card, which was used for the solution of each problem. Every procedure was planned by the whole group through collaboration and dialogue. The designation of all steps was guided and supervised by the experimenter and participants and was discussed collectively.

The orientation provided by an adult and the whole work in the group was used to form the following intellectual actions:

1. Design a scheme for the verbal situation expressed in the problem. Identification of the final question and of the elements of the problem are represented by the symbols  $M$ ,  $m$ ,  $v$ . ( $M$  = the magnitude of the object that is measured (modified);  $m$  = the unit of measurement;  $v$  = the number of repetitions of the same unit of measure).
2. Design a plan for solution of the problem. Identify and compare relationships among the data expressed by the words in the problem ( $M = ?$   $m = ?$   $v = ?$ ) (Figure 1).

1. Read the problem and find the question.
  2. Look for:  $M = ?$   $m = ?$ ,  $v = ?$
  3. Find the operation: 1)  $Ma + Mb = Mc$ ; 2)  $Ma - Mb = Mc$ ;  
3)  $M = m \times v$ ; 4)  $v = M / m$
  4. Solve the problem.
  5. Have you answered the question?

**Figure 1.** Orientation card for the solution of the problem

3. Find arithmetic operations that correspond to the operations of the solution. A formula for identifying the unit of measurement and the operations was used. In order to identify each operation properly another orientation card was designed (Figure 2). This card helped to organize the known and the unknown data for each problem.

<p>If the problem involves addition:</p> <p>a) We need to add b) We know the Magnitude c) We know the measure</p> <p>Formula: <math>MA + MB = MC</math></p>	<p>If the problem involves multiplication:</p> <p>a) We need to find the Magnitude (M) b) We know the measure (m) c) We know the number of times the measurement was used (v)</p> <p>Formula: <math>M = m \times v</math></p>
<p>If the problem involves subtraction:</p> <p>a) We need to subtract b) We know the Magnitude c) We know the measure</p> <p>Formula: <math>MA + MB = MC</math></p>	<p>If the problem involves division:</p> <p>a) We need to find the number of times the measurement was used (v) b) We know the measure (m) c) We know the Magnitude (M)</p> <p>Formula: <math>v = M \div m</math></p>

Figure 2. Orientation card for operations

Results

The study showed that the children were able to assimilate the orientation that was provided according to the revealed methodology. After the work with the orientation card and its content, different arithmetic problems were presented to the children. The children had to read the problem and identify all the elements according to the card. The card was used during all tasks in the group and was discussed orally. The process of reading, discussing, and solving the problems was carried out as external, guided, collective activity. Each child wrote down the elements of the orientation and the solution. They commented on and discussed all elements of the problem. They had to discover the elements and data of the problem and understand whether each of these elements or some of them were abundant in the problem. Some problems had no solutions, and the children commented on why no solution was possible. They were encouraged to verify each solution in the group. Figure 3 is an example of problem solution by one of the pupils. This task implied the operation of division. The children included in our study did not study

The car covered 98 km in 8 hours. How many km did the car cover each hour?

The image shows a student's handwritten solution to a word problem. On the left, the student lists the given data: 'D: M=98', 'm=8', and 'v:'. In the center, there is a long division calculation: 98 divided by 8, showing the steps 12 times 8 is 96, subtracted from 98 to get 2, then a zero is brought down to make 20, and 2 times 10 is 20, leaving a remainder of 0. To the right of the calculation, the student writes 'O=Division' and the formula 'F: v=M÷m'. At the bottom right, the final answer is written as 'R=12 km por cada hr' and 'R= 12 km per hr'.

Figure 3. Example of the solution of a simple problem

the operation of division formally, so they answered with wholes numbers, but they were able to understand the logic of the operations.

Figure 4 shows the problem with operation of multiplication, the children had to convert the measures of time.

Angel's sister eats 6 spoonfuls of porridge in 10 minutes, how many spoonfuls of porridge will she eat in 1 hour?

Datos.  
 $M = d?$   
 $m = 6$  cucharadas  
 $v = 60$  min.  
 $F.M = m \times v$   
 O. Multiplicacion  
 $M = \overset{du}{60} \times \overset{v}{6} = \overset{du}{360}$   
 $R = 360$  cucharadas  
 R = 360 spoonfuls

**Figure 4.** Problem requiring the operation of multiplication

So that they could analyze the data correctly and reflexively, problems with a lack of data and with an abundance of elements were presented to the children. The adult explained that in some cases problems may not have any solution if the data pre-

A group of second graders measured cartoon decorations. The lengths of the decorations were: Buzz Lightyear — 30 cm, Bullseye — 20 cm, Peter Pan — 25 cm, Jessie — 35 cm, Woody — 35 cm, SpongeBob — 25 cm, Blackboard — 15 cm, Patrick Star — 20 cm, Squidward Tentacles — 30 cm, Spiderman — 40 cm, and Sandy Cheeks — 30 cm. Which characters were the highest altogether — the *Toy Story* characters or the *SpongeBob SquarePants* characters?

D  
 $MA = 30$  cm  
 $MB = 20$  cm  
 $MC = 35$  cm  
 $MD = 35$  cm  
 $ME = 25$  cm  
 $MF = 20$  cm  
 $MG = 30$  cm  
 $MH = 30$  cm  
 O  
 Suma  
 $MA + MB + MC + MD + ME + MF + MG + MH = MT$

$\overset{du}{30} + \overset{du}{20} + \overset{du}{35} + \overset{du}{35} = \overset{du}{120}$   
 $\overset{du}{25} + \overset{du}{20} + \overset{du}{30} + \overset{du}{30} = \overset{du}{105}$

R = toy story son los personajes mas altos

R = the toy story characters are the highest

**Figure 5.** A problem requiring identification of essential and irrelevant data

sented are not sufficient. In such cases it is not possible to answer the final question. In other cases, the text of the problems may mention details that are not essential for the mathematical solution. Such reasoning helped the children to consciously reflect on and abstract mathematical data from the verbal texts of the problems (Talizina, 2009). Figure 5 is an example of the solution to a problem that required identification of necessary data about characters in the *Toy Story* films and the *SpongeBob SquarePants* television series. The children had to distinguish essential characters (e.g., Buzz Lightyear, Bullseye) from irrelevant characters (e.g., Spiderman). Afterward, the children wrote the formulas and solved the problem according to the steps they identified.

While advancing according to the program, the children started to ask questions more quickly and their realization of and verbal comments regarding all steps became unnecessary. After five problem tasks it was unnecessary to mark with a pencil the given data and the final question, and it was possible only to ask the children about the data and the question. This progression shows how external action with many steps became a reduced and automatized intellectual operation (Galperin, 1957/2011, 1959b/2011; Luria, 1980).

After the children solved simple problems (12 lessons), it became possible to include complex problems with more than one operation. In such problems the final questions were not answered in a direct way but by several steps. Each step consisted of answering a sequential question before answering the final question. The children learned how to establish sequential questions according to the problems. The difficulty was that the sequential questions did not appear in the texts of the problems. It was thus necessary to work on the analysis and determination of such intermediate questions. Figure 6 is an example of the problem with two types of units for measuring (decimal numeric system and volume). The children had to organize the data of the problem and convert units of measurement into the same unit (conversion of liters into milliliters).

Daniel collected 150 balls; Axel brought 7 liters of lemon water; Renata put 9 racquets together; Santiago brought 350 milliliters of lemon water. How many toys and milliliters of water did the students have?

<p><b>Datos</b></p> <p>MA = 150 juguetes</p> <p>MA = 7 L</p> <p>MC = 9 raquetas</p> <p>MD = 350 ml</p> <p>R = 159 juguetes</p> <p>R = 1350 ml</p>	<p><b>Operación: Suma</b></p> <p>Formula: <math>MA + MC = M1</math></p> <p><math>MB + MD = M1</math></p> <p><math>150 + 9 = 159</math></p> <p><math>350 + 1000 = 1350</math></p> <p>R = 159 toys</p> <p>R = 1350 milliliters</p>
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**Figure 6.** Complex problem with the conversion of a unit of measure (volume)



Figure 7 shows the conversion of units of measurement of time (conversion of weeks into days).

Renata has found 42 different puzzles that she wants to do in 2 weeks. How many puzzles will she have to do each day?

**Datos:**  $M=42$ ,  $m=14$ ,  $v=?$

**Formula:**  $v = M \div m$

**Operation:**

$$\begin{array}{r} 42 \\ -14 \\ \hline 28 \\ -14 \\ \hline 14 \\ -14 \\ \hline 0 \end{array}$$

1 semana = 7 días  
2 semanas = 14 días

**R=3 rompecabezas por cada día.**

R= 3 puzzles per day

Figure 7. Complex problem with the conversion of units of time

Yola has 40 pencils. She wants to divide all pencils among 10 friends. How many pencils did Yola give to each of the children?

**b.  $M=40, m=10$**

Si Yola tiene 40 lápices y los quiere repartir entre 10 alumnos, ¿Cuántos lápices le tocará a cada uno?

**D.**  $M=40$ ,  $m=10$

**F.**  $v = M \div m$

**O.**

$$\begin{array}{r} 4 \\ 10 \overline{) 40} \\ -10 \\ \hline 30 \\ -20 \\ \hline 10 \\ -10 \\ \hline 0 \end{array}$$

**R=4 lápices le tocará a cada alumno.**

Yola gives 4 pencils to each of her students

Figure 8. Solution of created problem with the operation of division

Finally, the creative stage of the program took place. In this stage the children had to create problems with proposed verbal content and numeric relations. For this purpose, orientation with some numeric data was provided to the pupils, while they had to propose and write down a verbal situation that included and mentioned these data. Afterward, the children were able to create all elements (verbal texts and numeric relations) independently. The pupils exchanged problems for independent solution.

Figure 8 shows a problem created by one of the pupils that was solved by another pupil. The given data included magnitude (40) and a unit of measurement (10). The pupils managed to recognize the relationships among the data and chose the operation of division from the contents of the problem.

Figure 9 is an example of the creation of a problem according to given numeric data. A pupil created the verbal text for the problem independently.

Reny bought 50 candies, and her mother gave her 10 candies. Reny ate 25 candies on Monday and she ate 3 candies on Tuesday. How many candies does she have left?

a. MA= 50, MB= 3, MC=25 y MD=10

Reny tiene 50 dulces y le regalan 10, el Lunes se come 25 y el Martes se come 3 ¿Cuántos tiene en total?

D. DU  
M=50 + 10 = 60 - 25 = 35 - 3 = 32

R=32 tiene en total.

R= Reny has 32 candies

**Figure 9.** Creation of a problem for the operations of addition and subtraction according to given numeric data.

Finally, the children worked independently to create individual problems according to given numeric data. The children chose the data and proposed different relationships among them. The pupils exchanged their created tasks for solution by other pupils. Figure 10 is an example of such a task.

During the process of working with the program, qualitative analysis of the structure of the elements of the intellectual activity of problem solving was performed. For each element specific errors and difficulties were detected. Table 2 shows the results for an initial assessment according to types of mistakes and difficulties in problem solving.

My plants receive water 2 times per day. How many times will my plants receive water in 11 days?

Si riego mis plantas 2 veces al día ¿cuántas veces las riego en 11 días?

Datos:  
 $M = 22$   
 $m = 11$  días  
 $v = 2$  veces

Operación: Multiplicación  
 Fórmula:  $M = m \times v$   
 $2 \times 11 = 22$        $R = 22$  times

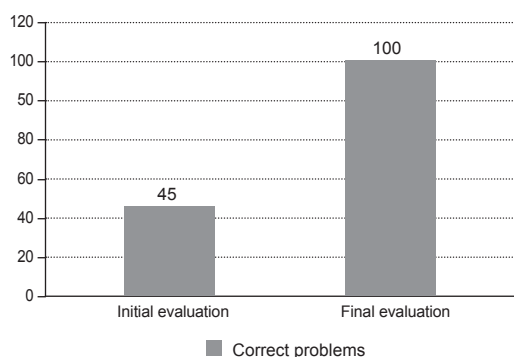
Figure 10. Independent creation of a problem by a pupil

Table 2. Types of errors detected during initial assessment

Element of problem solving	Types of difficulties and errors
Identification of the final question	a) Impulsive answers, anticipation of the answer without paying any attention to the final question. b) Difficulties in finding the final question.
Identification of the relevant data	a) Impossibility of identifying the required unit of measurement. b) Impossibility of understanding the function of converting the data to only one unit. c) Difficulties in understanding the relationships between the text of the problem and the mathematical operations.
Performance of the procedure	a) Use of fingers during operations. b) Difficulties in explaining the steps. Mechanical solution by any kind of arithmetic operation. c) Difficulties in identifying the concept of <i>digit</i> and the concept of <i>positional unit</i> .

The difficulties and mistakes presented in Table 2 indicate the existence of a developed ability for problem solution. The children intended to solve the problems with no reflection or understanding of the structure and purpose of the problems. Such difficulties disappeared after the participation of the children in the formative program. Figure 11 shows the percentage of correct answers during problem solution before and after participation in the program. The children were able to assimilate the proposed orientation and even started to work without any kind of

external help. They also were able to create and solve independent problems at the last stage of the program. They performed numeric operations in a correct and rapid way without using their fingers or other material aids.



**Figure 11.** Comparison of correct answers in initial and final assessment, percentage

## Discussion

The results obtained during the formative experiment prove the possibility of formation of the ability not only to solve problems but also to create independent problems. The executions of the children were initially not automatized and were chaotic, with mechanical application of arithmetic operations with no reflection. Later on, the pupils developed the important ability of reflecting on the situation presented in the problems. Our data show that one of the essential elements of such reflection was understanding of the separation of the verbal content of the problem from the numeric relations among the presented data. The absence of such mental separation can be understood as one of the specific difficulties that exist in primary school with the task of problem solution. Another difficulty is the absence of orientation for identifying the final questions and steps and for the obligatory conversion of the data to only one unit of measurement. Final assessment allowed us to observe logic argumentation together with automatization and interiorization of the structural analysis of the content of the problems. Similar results were obtained in previous formative experiments conducted for studying the initial aspects of numeric and logical concepts and operations with Mexican children (Rosas & Rosas, 2011; Rosas et al., 2014; Solovieva et al., 2010; Solovieva, Rosas, & Quintanar, 2013; Solovieva et al. 2014; Zárraga et al. 2012) and for solving problems with Russian and Romanian children (Nikola & Talizina, 2001; Salmina, 2001).

Consideration of the structural components of each task permits the elaboration of an appropriate orientation for the formation of each necessary element. Such an analysis is based on theoretical and methodological findings of activity theory applied to the process of teaching and learning in general (Galperin, 1959a/ 2011; Podolsky, 2010; Talizina, 2000) and specifically to the content of broad mathematical abilities (Butkin, 2001; Talizina, 2001; Volodarskaya, 2001). Such a directed and oriented manner of teaching guaranteed the continuation of systematic knowledge. For example, the children had to identify the relationships of the concept of num-

ber, the concept of the decimal system, and the positional value of digital and arithmetic operations. Frequently, such aspects of knowledge are presented separately and in different grades so that children may find no connections among these kinds of knowledge. We believe that systematic organization of the content of the matter of mathematics might help to achieve increased understanding and even to elevate the level of motivation in pupils. The possibility not only to solve but also to create and exchange problems is also an important method for elevation of the level of interest and motivation. Our proposal helps to avoid mechanical naming of the parts of numbers as the only way to reflect on the concept of the decimal system. An example of such a method is the constant reading of numbers: for example, the reading of 329 as 300, 20, and 9 without any explanation of the necessity for such a reading. Such “reading” of numbers provokes only confusion and misunderstanding in primary school pupils (Bermejo, 2008; Castaño, 2008).

The method of the gradual formation of mental actions according to activity theory (Galperin, 1959b/2011, 1957/2011; Solovieva, Pelayo, & Quintanar, 2011; Talizina, 2001, 2009) establishes clear content for the process of teaching. Elaboration of the proper orientation for each school action helps to achieve concrete goals for each task that follows and accompanies the learning process. From this perspective, the role of the teacher and the methods used for teaching are essential for analysis of pupils’ success in solving mathematical problems. The contrast of our approach to the learning process and the approach of others can be seen by comparing the proposals for observation of the spontaneous strategies used by pupils and the selection of some of these strategies (Butto & Gómez, 2014). Another such proposal is analysis of the cognitive styles of children within the learning process (Padilla & López, 2006; Toledo, Pérez, Riquelme, Hernández, & Bittner, 2011).

Our results confirm Leontiev’s (2003) opinion of the role of culture in cognitive development. Such developments cannot appear directly from culture; specific activity needs to take place to guarantee such development. Only activity can provide the proper type of interaction between teachers and pupils. The object of appropriation must be included as a particular object of joint guided activity. In other cases, it would not be possible to guarantee the success of the learning process. Our results show that oriented joint activity helped our participants to form conceptual and independent strategies for the solution of problems. At the beginning of the study pupils had no such strategy at all. Their strategies were obtained in mutual collaborative situations that had clear meaning and purpose for children. Cognitive sense and real experience (Del Río & Álvarez, 2011) were obtained not by declaring the necessity of social collaboration but by concrete organization of the situations of problem-solving. A strong part of our study was the realized possibility of creating a specific orientation and of including participants who did not originally show an orientation toward mathematics or problem solution. Reflection on the verbal and numeric content of the problems was achieved through our formative experiment. Our children started to show a positive attitude toward mathematics. They were enthusiastic and interested in the solution of problems and in the creation of their own problems. They were interested in correct answers and in understanding each step of problem solution and creation. They started to verify their actions and to help each other. According to Leontiev (2003), motives might increase within

oriented activity, and we believe such was the result of our experiment. As one of the children said, “I do not want go home ’til I finish my problem. I have to read it once again and understand the question of the problem.”

### Limitations

We are aware that the group of participants in the process of formation was extremely small. The reason for having such a limited number was the fact that the school was completely new at the time of research. However, it is also rather difficult to get permission to use innovative formative procedures in common public educational institutions in Mexico, as in many other countries. Difficulties arise when researchers try to look for control groups in order to compare results with those in traditional teaching institutions. The possibility of comparing obtained results with control groups should become a part also of qualitative research, but it is not always possible in the system of traditional education in Latin America.

### Conclusion

Solution of mathematical problems is not a spontaneous ability that might just appear in the classroom. Specific guided orientation is a useful teaching tool to guarantee proper understanding of the elements of problems and steps for their solution. The method of the gradual formation of mental actions step by step is a strong methodological strategy that may modify positively the analysis of the process of teaching and learning. Reflection by children might be formed together with positive motivation by giving detailed consideration to the organization of the learning process in primary school. Qualitative research in psychology and pedagogy should be considered a useful way for analyzing and reorganizing educational practice.

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## Development of children's early understanding of numeric structure

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Understanding of the base-10 structure of multi-digit numbers is one of the critical aspects in early mathematics learning. It has been documented that children from different countries vary in their use of base-10 representations. Questions concerning potential sources of this variability have been debated for decades. One commonly posited explanation is that some languages provide explicit cues about the structure of multi-digit numbers, facilitating the development of base-10 representations. In the present study, we tested this view against an alternative view, positing that variability in children's learning of numeric structure may reflect differences in their experiences with numbers. The study examined kindergartners and first-graders from four countries: Taiwan, South Korea, the USA, and Russia. Results showed that the use of base-10 representations by American first-graders increased dramatically over the last decades, following changes in curricular guidelines. First-graders across the four countries showed some differences in performance (however, not consistent with the language account), whereas kindergartners performed comparably despite the differences in their languages. The results suggest that the nature of early math instruction may be critical for children's developing understanding of numeric structure.

**Keywords:** mathematics learning, numeric system, numeric representations, cross-national study, kindergartners

### Introduction

#### *Early conceptual development in mathematics: Understanding base-10 structure*

The significance of children's development of mathematical understanding for their subsequent academic and professional success has been well established (e.g., Aubrey, Godfrey & Dahl, 2006; Jordan, Kaplan, Ramineni, & Locuniak, 2009). In particular, a strong basis in mathematics is critical for success in a variety of scientific

and technological disciplines. One of the questions debated over the years concerns the educational approach that would lead to optimal learning of mathematics during the early years of schooling, when the foundations of future knowledge are being built. Both researchers and educators have emphasized that early math skills should be acquired in a meaningful way—not simply by memorizing a set of numeric facts and procedures, but rather by connecting the learning of these facts and procedures to a conceptual understanding of numbers and numeric relations (Byrnes & Wasik, 1991; Hiebert, 2013).

One of the critical conceptual developments in early mathematics concerns understanding of the *hierarchical base-10 structure of the numeric system*, i.e., the idea that a multi-digit number is composed of ones, tens, hundreds, etc. (e.g., Geary, 2006). It is believed that knowledge of the base-10 structure facilitates accurate problem-solving (Fuson & Briars, 1990). In particular, when children solve arithmetic problems mentally, their choice of efficient computational strategies can be predicted by their base-10 knowledge (Laski, Ermakova, & Vasilyeva, 2014). Consider, for example, a double-digit addition problem, such as  $45 + 23$ . When solving this problem, decomposition (e.g.,  $45 + 23 = (40 + 20) + (5 + 3) = 68$ ) offers a more efficient and less error-prone strategy than counting on (e.g.,  $45 + 23 = \dots 46, 47, 48, 49, \dots 68$ ). The choice of decomposition strategy depends in part on how children represent the two-digit addends. Those who are able to represent a number as a combination of tens and ones (e.g., 45 is four tens and five ones) should be more likely to apply decomposition, compared to those who do not think about numbers in terms of their base-10 structure, but rather tend to represent them as collections of single units.

Before formal schooling, most children think of numbers larger than 10 as collections of units rather than as groups of tens and ones (Mix, Prather, Smith, & Stockton, 2014). It takes several years for children to develop an understanding of the base-10 system and place-value notation (Fuson, 1992; Fuson & Briars, 1990; Varelas & Becker, 1997). Yet the dynamics of acquiring this foundational aspect of mathematical knowledge appear to vary across cultural and educational backgrounds. In particular, research conducted almost 30 years ago suggested that American children lag behind their counterparts from East Asian countries, such as China, South Korea, and Japan, in performance of tasks that require understanding of the base-10 structure (Miura, 1987).

One task that is commonly used to assess children's understanding of the base-10 structure is a *block task* (e.g., Miura, Okamoto, Kim, Steere, & Fayol, 1993), in which children are asked to "show" two-digit numbers using blocks that include small cubes representing single units and bars that represent 10 units combined together. If children think of numbers as collections of single units, they will represent a number, such as 32, using 32 individual unit cubes. If, however, children understand the base-10 structure of numbers, they are more likely to do so using three ten-bars and two individual units. When this task was presented to first-graders from the US and Japan, the Japanese children were more likely to use base-10 representations (combinations of ten-bars and single units), whereas their American counterparts tended to use only single unit cubes to represent the same numbers (Miura & Okamoto, 1989).

### ***Potential sources of differences in children's understanding of base-10 structure***

Given the significance of children's conceptual understanding of the hierarchical numeric structure for future math learning, it is important to explore potential sources of the observed differences in the acquisition of this concept. One explanation that emerged in prior work posits that it is the nature of the numeric language that may facilitate or impede children's understanding of the structure of multi-digit numbers. The idea is that number words in some languages, such as Chinese, contain explicit cues about the hierarchical base-10 structure of the numeric system. For example, the literal translation of the Chinese word for 11 is "ten-one", 12 is "ten-two", 20 is "two-ten", 35 is "three-ten five", and so on. Thus, the wording reveals and possibly draws attention to the base-10 structure of multi-digit numbers. In contrast, number words in languages such as English and Russian do not provide as clear base-10 information about the number, possibly putting these children at a disadvantage in learning about numeric structure.

Even though the language account appears to provide a logical explanation for the differences originally found when comparing American and Asian students, it is important to disentangle the role of linguistic factors from the role of other cultural and educational factors associated with mathematics learning. While there is clear variability among linguistic systems in number naming, there is also variability in educational contexts that may affect learning (Perry, 2000; Stigler & Stevenson, 1992). In other words, it is possible that differences in educational experience, rather than (or in addition to) language-based numeric representations, account for the differences in students' understanding of the base-10 structure. It is particularly useful to understand the extent to which instruction may affect this phenomenon because, unlike language features, school instruction is a factor that can be changed based on the evidence of best practices.

Consider potential differences in curricular approach that may facilitate or impede the use of base-10 representations on the block task. Some instructional systems may introduce children to the concept of hierarchical organization of the numeric system and may use activities, such as counting by tens or decomposing two-digit numbers into tens and ones, early on in classroom instruction. Others may focus initially on mastering simple number facts (such as single-digit addition) and counting by ones. Furthermore, the use of base-10 decomposition strategy in arithmetic calculations is likely to have a bi-directional relation with children's understanding of the base-10 structure. On the one hand, as shown in prior work, children who have a better conceptual understanding of the structure of multi-digit numbers are more likely to use a decomposition strategy in arithmetic (Laski et al., 2014). On the other, repeated practice using this strategy may solidify children's understanding of the numeric structure. Thus, explicit discussion of the base-10 structure and emphasis on using the base-10 decomposition strategy may facilitate growth of students' base-10 knowledge.

### ***The present study***

The present study was designed to investigate the role of educational experience, in comparison to language, in the development of children's number representa-



tions. As a basis for our investigation, we took Miura's (1987) experimental task, in which children were asked to represent two-digit numbers with single units and ten-blocks. Our goal was to determine how the use of base-10 representations varied with the math experience, as well as language, of participating students. The participants were recruited from the USA, Russia, Taiwan, and South Korea. English speakers are commonly compared with speakers of Asian languages when examining linguistic factors related to math performance. The inclusion of Russian students provided a comparison case that was particularly relevant to the present investigation due to the characteristics of mathematics instruction in Russian elementary schools, as well as the features of the Russian counting system that are less transparent than in Asian languages.

Because the present study was focused on the potential role of instruction, it is important that the instructional approaches in the four countries—Russia, Taiwan, South Korea, and the US—vary in notable ways. The approach used in some Russian elementary schools, including those that participated in the present study, emphasizes the mastery of basic computational skills at the early stages of math instruction, as well as children's ability to solve word problems that involve simple math facts. In contrast, much of the effort in the initial elementary instruction in Taiwan and South Korea is focused on developing a concept of number, understanding the structure of number and the ways in which numbers relate to each other. US instruction has undergone substantial changes over the years, with the focus shifting from the mastery of number facts to a deeper understanding of numeric structure, as discussed below. Taking into consideration the variability in both linguistic and instructional environments across the four participating countries, we aimed to determine whether children's performance in our study was more consistent with the linguistic or instructional account. Towards that goal, we addressed several research questions.

**Have students' numeric representations changed over time, following changes in instructional practices?** Examining trends in children's cognitive performance over the past decades can be useful for understanding underlying mechanisms of development. For example, the discovery of the Flynn effect (generational increase in IQ scores) highlighted the role of environmental factors in the growth of intellectual functioning (Flynn, 1987). In the present study, we were interested in determining whether cross-national differences in base-10 representations observed 25 years ago (Miura, 1987) would be reproduced in the performance of contemporary students. While numeric language has remained constant over this period of time, mathematics instruction in the US has undergone substantial changes (Hiebert, 2003; National Research Council, 1989, 2001; Rampey, Dion, & Donahue, 2009). These changes were in part stimulated by research revealing American students' weaknesses in understanding key mathematical concepts (National Research Council, 2001). As indicated above, the current curricular guidelines emphasize the need for developing a better understanding of the numeric system, including the base-10 structure of multi-digit numbers. If the pattern of cross-national differences in performance on number representation tasks has changed over time, it would underscore the role of instruction in the development of base-10 representations.

**Are cross-national differences in kindergartners who have limited instructional experience parallel to those in first-graders?** Most studies reporting lin-

guistic effects on children's number representations have relied on data obtained with first-graders (Miura, 1987; Towse & Saxton, 1997). However, math performance in first grade may reflect, at least in part, effects of instruction. This view is supported by a study of Japanese students, which showed increased use of base-10 representations by first-graders compared to same-aged kindergartners (Naito & Miura, 2001). In the present study, we examined cross-national patterns in first-graders as well as kindergarten students. Kindergartners present an interesting case for cross-national comparison, because they are proficient speakers of their language, who have a numeric vocabulary that extends beyond the first 10 numbers; yet, their exposure to math instruction is more limited than that of first-graders. Our preliminary interviews with teachers indicated that by the time of the study, kindergartners in all four nations were familiar with two-digit numbers, but only in the context of rote counting routines.

If the tendency of Asian students to use base-10 representations is largely driven by the features of their language, then we should expect Asian kindergartners to show this tendency. While younger children may be less accurate in reading numbers or counting blocks, the relative use of base-10 representations should be higher in kindergartners speaking more transparent languages. If, on the other hand, math instruction plays the key role in developing base-10 representations, two predictions can be made: (a) kindergarten students in each country should be less likely to use such representations than first-graders, and (b) cross-national differences among kindergarten students should be smaller than among those in first grade.

Furthermore, given their limited experience with two-digit numbers, kindergartners may be affected by the type of practice they receive on the number representation task. Saxton and Towse (1998) argued that English-speaking first-graders in their study may have lacked experience with number tasks and, therefore, were particularly sensitive to the experimenter's demonstration during practice trials. If this is true, then kindergartners, including those from Asian countries, may also perform differently depending on the type of practice provided. Thus, in the present study we examined the performance of first grade and kindergarten students in two practice conditions: one involving single-digit numbers only (where the experimenter modeled only single unit representations) and the other involving both single and two-digit numbers (where a base-10 representation was modeled by the experimenter).

**Is performance affected by the transparency of number words or by children's experience with numbers?** As discussed above, the Korean and Chinese languages have a number system that captures the base-10 structure for any number above 10. English and Russian are less numerically transparent languages, and the degree of transparency varies across numbers. Consider, for example, the word for the number 12. In Mandarin, the word is "shi-er", which literally means "ten-two". Similarly, in Korean, the word is "ship-yi", which also means "ten-two". In Russian, the word is "dvenadtsat" or "two-on-dzat" (where "dzat" is an archaic word that in the distant past meant "ten", but has not been used in modern language as a separate word with this meaning). Finally, in English, the word is "twelve", which contains the least number of clues about the composition of the number as two and 10. Yet, for larger numbers, the base-10 structure becomes more transparent in both English and Russian. Thus for example, "61" sounds like "liu-shi-yi" (six-

ten-one) in Mandarin, “yook-ship-il” (six-ten-one) in Korean, “shestdesyat odin” (six-ten-one) in Russian and “sixty-one” (six-ty-one) in English.

In the present study, we selected target numbers so that their names varied in terms of the explicitness of the base-10 structure. A linguistic account suggests that English- and Russian-speaking children may be more likely to generate a base-10 representation for more transparent than for less transparent targets (e.g., “sixty-one” versus “twelve”). If, on the other hand, children’s number representations are largely shaped by mathematical experience, one would expect a different pattern. As children tend to have more experience with smaller numbers, they may have a better idea about “12” as a quantity comprised of one ten and two single units and thus may be more likely to produce base-10 representations for smaller, than for larger, numbers.

Method

First grade and kindergarten students were given the same number representation task with two-digit numbers. Half the students were tested in the single-digit practice condition, and the other half in the mixed-digit practice condition. During test trials, students were allowed to show the number any way they wanted. This task provided a window into how children spontaneously think about two-digit numbers—i.e., whether the first type of representation that comes to their minds involves a combination of tens and ones or a collection of ones.

Participants

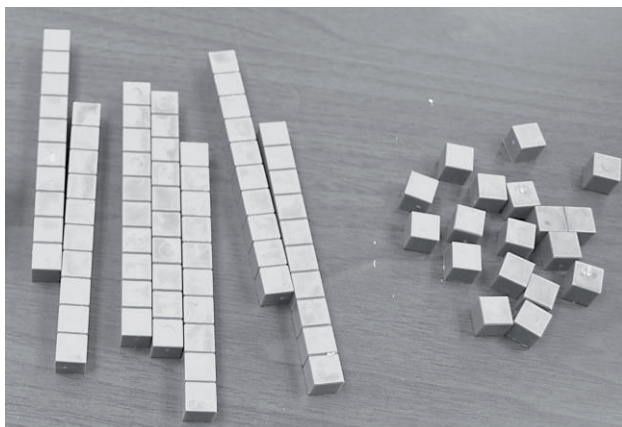
The study included a total of 598 students: 272 kindergarten students and 326 first-graders. The US sample was recruited from suburban schools (public and private) in the state of Massachusetts. The Korean sample was recruited from public and private schools in a suburb of Seoul. The Russian and Taiwanese samples were recruited from public schools in the capitals—Moscow and Taipei, respectively. The participants from all four countries attended schools in districts that served families from middle- and upper-middle-class backgrounds. Table 1 presents the number and characteristics of participants from each country.

Table 1. Sample characteristics by grade and country

<i>First Grade</i>	Number of students	Mean age in months (age range)	Percentage of female students
USA	93	86 (77-96)	52%
Russia	113	91 (82-101)	50%
Taiwan	60	88 (81-98)	53%
S. Korea	60	86 (82-92)	58%
<i>Kindergarten</i>			
USA	90	73 (61-84)	57%
Russia	60	81 (68-89)	50%
Taiwan	62	76 (68-81)	47%
S. Korea	60	73 (67-80)	50%

### **Materials**

Materials in this study included a set of plastic blocks that consisted of small cubes (unit-blocks), each representing a single unit, and longer bars (ten-blocks) with the 10 single-unit segments marked, as shown in Figure 1. Thus, one ten-block was equivalent to 10 unit-blocks. At the start of the study, 100 unit-blocks and 20 ten-blocks were placed in separate trays.



**Figure 1.** Materials used in the block task

Materials included numeral cards that were printed on heavy construction paper; each card was 10 cm x 10 cm in size and displayed a single number printed in the middle of the card. Three cards were used for the practice trials (the numbers 2, 7, and 14). Depending on the practice condition, children were presented either with the cards showing the numbers 2 and 7 or with the cards showing the numbers 2 and 14. Five cards were used for the test trials (12, 16, 28, 34, and 61). These numbers were chosen because they represent a range of tens and ones, and also because they afford different degrees of transparency of numeric structures.

### **Procedure**

Children across countries and grade levels were tested following identical procedures, which consisted of an introduction phase, followed by two practice trials and five test trials.

**Introduction.** The tester pointed to the trays with unit- and ten-blocks which were placed on the table in front of the child, and explained that these blocks could be used to show numbers. The child's attention was drawn to the fact that there were different kinds of blocks and that the long one was the same as 10 small ones. To demonstrate this, the tester took one ten-block and 10 single unit-blocks from the trays and lined up the unit-blocks against the ten-block while counting from 1 to 10.

**Two practice trials.** The introduction was followed by practice trials, during which the tester presented the child with a number card (e.g., 7), saying: "Now, I'll show you how we can make this number using the blocks". The tester

chose the appropriate number of blocks and placed them next to the card, saying, "Look, this shows 7 [pointing to the card] and this shows 7 [pointing to the blocks]". Students in each classroom were randomly assigned to either the single-digit or mixed-digit condition. In the single-digit condition, children received practice trials with the numbers 2 and 7, which were constructed by the tester using unit-blocks. In the mixed-digit condition, children received practice trials with numbers 2 and 14. To represent 14, the tester used one ten-block and four unit-blocks.

**Five test trials.** The practice was followed by test trials. In each trial, children were presented with a number card (e.g., 12) and were told that now they had to show the number using the blocks. They were given an empty tray on which the number representation was to be created. The five number cards (12, 16, 28, 34, 61) were presented in random order to each child. After the child finished constructing the number representation from blocks, the response was documented on the answer sheet. The tester recorded how many blocks of each kind (single-unit- and ten-blocks) the child used to represent a given number. Further, the tester wrote comments to describe particular features of the child's response (e.g., whether the child arranged blocks in a certain shape or made comments that could be helpful in coding).

**Coding of responses.** Number representations constructed by children during test trials were categorized based on a coding scheme that captured the nature of the children's responses. This scheme was partly based on prior work that had distinguished three categories: canonical and non-canonical base-10 representations, and single unit collections (Miura, 1987; Saxton & Towse, 1998). A response was coded as a "*canonical base-10 representation*" if the child used the largest possible number of ten-blocks to represent the tens in the two-digit number and used single unit-blocks to represent the ones. For example: 12 would be represented with one ten-block and two unit-blocks; 28 would be represented with two ten-blocks and eight unit-blocks, etc. A response was coded as a "*non-canonical base-10 representation*" if the child used some ten-blocks (but not the maximum possible quantity) and more than nine unit-blocks. Such a strategy could be used only on trials with target numbers 28, 34, and 61. For example, 28 could be represented with one ten-block and 18 unit-blocks, 34 could be represented with two ten-blocks and 14 unit-blocks, etc. A response was coded as a "*single-unit representation*" if the child used only single-unit blocks to represent the entire number. For example, 12 would be represented with 12 unit-blocks and 61 would be represented with 61 unit-blocks.

In addition to these three categories, based on performance observed in our study, we added two more types of representations that did not fit into previously described categories. One of them was "*unit confusion: no distinction between tens and ones*". This category was used when the child either used ten-blocks to represent the ones or unit-blocks to represent the tens in the target number. For example, number 12 could be represented with 12 ten-blocks, each supposedly standing for a single unit. Even more interestingly, the child could represent the number 12 with three unit-blocks: one of them was placed separately to represent 10 (as evidenced from the child's comment), while the other two blocks were placed at another spot

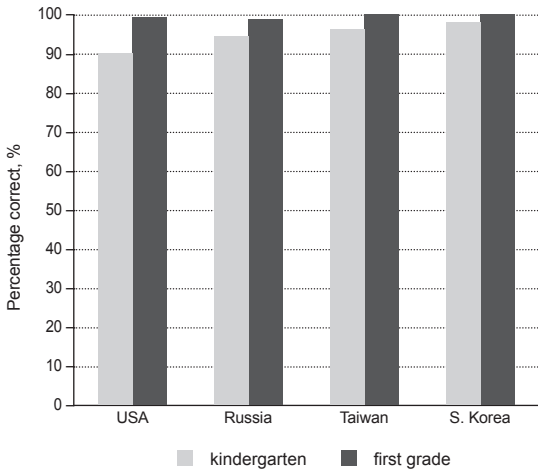
on the tray, each representing a single unit. Another category observed in children’s performance was a “*shape-based representation*”, in which the child depicted the shape of each numeral with the blocks rather than representing the quantity. For example, the number 12 could be drawn using single unit-blocks to show the form of “1” and “2”. These two categories were relatively rare, but coding them allowed us to capture a fuller range of strategies used at different grade levels.

Finally, children’s responses that did not fit into any of the above five categories were coded as “*other*”. This category also included guesses (when the child grabbed a random number of unit-blocks and placed them on the tray in a pile, without counting) and non-responses. This category included some extremely rare strategies that comprised less than 0.5% of all responses, such as representing the number “28” with three ten-blocks and then covering with a figure two single units within one of the blocks to arrive at 28.

## Results

### *Representational accuracy*

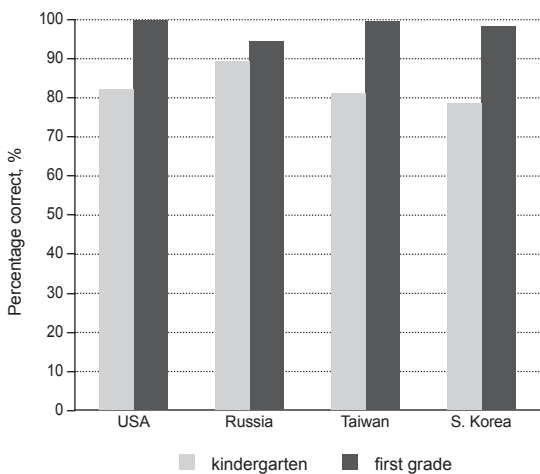
We began our analysis by examining whether children were able to accurately name the target number shown on the card, which indicated the extent of their familiarity with two-digit numbers. Such familiarity can be viewed as a prerequisite for solving our block task. Indeed, a child who cannot name any of the numbers presented in the test cannot be expected to accurately represent the quantity corresponding to that number. Our examination showed that first-graders were 99% correct in naming the numbers presented to them and kindergartners were, on average, 94% correct. Figure 2 depicts naming accuracy results by country and grade. Note that even though kindergartners were less accurate than first-graders, their accuracy levels were still very high—90% and above in each country. Furthermore, there were no children in either age group who named more than two numbers incorrectly, indicating that the participants were sufficiently familiar with the written representation of two-digit numbers.



**Figure 2.** Accuracy in naming numbers



In the next step, we examined how accurately children were able to represent the quantity corresponding to the target number using the blocks. A response was considered correct if the value of the blocks used by the child added up to exactly the number shown on the card (regardless of the kind of representation used). For example, if 28 was represented with 28 single units or one ten-block and 18 single units, it was coded as correct, but if 28 was represented with 23 single units or one ten-block and eight single units, it was coded as incorrect. The results are presented in Figure 3. A 4 (Country)  $\times$  2 (Grade) ANOVA, with the accuracy of representations across five trials as the dependent variable, produced a single significant finding: a main effect of grade,  $F(1,590) = 53.77$ ,  $p < .001$ ,  $\eta_p^2 = .08$ , with first-graders producing more accurate representations than kindergartners (98% and 82% correct, respectively).



**Figure 3.** Accuracy in representing numbers

About a quarter of all errors (26.5%) were due to inaccurate counting (e.g., when a child who used only unit-blocks double-counted some of them and as a result represented 61 with 59 blocks). In contrast to such “mechanical” counting errors, other errors reflected conceptual difficulties with the task, when children chose inappropriate representational strategies—for example, using unit-blocks to represent tens. Below we examine in-depth children’s performance on the block task, investigating potential factors affecting their ability to create appropriate representations of numbers.

### ***Representational strategies***

The main focus of our analysis was on the types of number representations constructed by the children. Table 2 illustrates the different ways in which children in the current study represented two-digit numbers, as well as the frequencies of each type of representation. Consistent with previous studies, we found that the most common types of representations across the four countries were canonical base-10 and single-unit. At the same time, important differences emerged in the current findings, relative to those of earlier studies.

**Table 2.** Percentage of representations in each category (across the two practice conditions)

	Canonical base-10	Non-canon- ical base-10	Single unit collection	Unit confu- sion	Shape- based	Other
<i>First grade</i>						
USA	90	1	9	0	0	0
Russia	75	4	16	2	2	1
Taiwan	98	0	2	0	0	0
S. Korea	95	1	4	0	0	0
<i>Kindergarten</i>						
USA	48	8	30	2	9	3
Russia	56	7	28	2	3	4
Taiwan	57	7	19	6	3	8
S. Korea	53	3	27	7	3	7

**Changes in students' number representations over time.** Table 3 indicates a frequent use of canonical base-10 strategies in American first-graders. This finding suggests a change in performance over the 25 years since the original cross-national research on number representations (Miura, 1987). It should be noted, however, that the studies by Miura and colleagues only included a single-digit practice condition, whereas our study also included a mixed-digit condition. To make a more accurate comparison, we computed the percentage of different strategies used by our participants in the single-digit condition only. Table 3 presents data for the comparison of the two studies. These data reveal changes in performance over time, even when using a parallel procedure and participants from comparable backgrounds. The use of base-10 representations has increased in all three countries, but the most dramatic change has occurred in the performance of American first-graders.

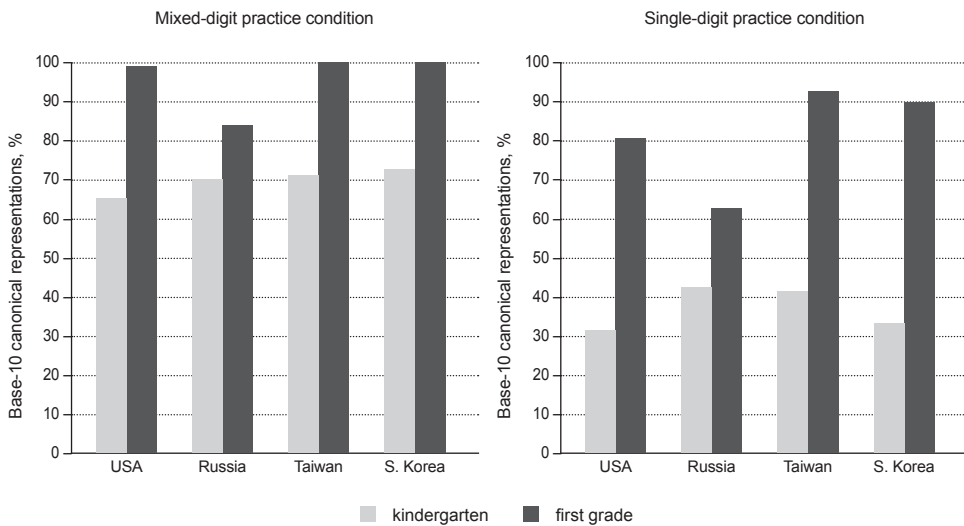
**Table 3.** Percentage of base-10 and single-unit representations used by first graders: Comparison across studies

	Canonical base-10	Non-canonical base-10	Single unit collection
<i>Miura et al (1988)</i>			
USA	8	1	91
China	81	9	10
S. Korea	83	11	6
<i>Present study (2013)</i>			
USA	81	1	18
Taiwan	96	1	3
S. Korea	91	2	7

*Notes.* Results for the present study are from the single-digit practice condition, which is parallel to the condition used in Miura's (1988) study. Chinese participants in that study and Taiwanese participants in the present study were speakers of Mandarin.

**Differences across grade levels.** Comparing responses of first grade and kindergarten students, we made several observations. First, the use of base-10 representations was more frequent among first-graders than kindergartners, whereas the use of single-unit collections showed the inverse pattern (see Table 2). Further, in addition to using base-10 and single-unit representations, kindergartners used a range of erroneous strategies, albeit infrequently. For example, some students reproduced the shape of the target number, despite having had two practice trials in which blocks were used to represent numerical values. Others did not fully understand the value of ten- and unit-blocks, using them interchangeably. In contrast to kindergartners, first-graders in three of the four countries did not use erroneous representations.

We conducted a  $2$  (Grade)  $\times$   $4$  (Country)  $\times$   $2$  (Practice Condition) ANOVA, with the percent of canonical base-10 representations as the dependent variable. (Note that we ran two parallel analyses: one examining responses on all trials and the other considering only the trials where children produced accurate names and representations of target numbers. The pattern of results was the same. Statistics reported here are based on all trials.) We found main effects of grade,  $F(1, 582) = 155.10, p < .001, \eta_p^2 = .21$ , country,  $F(3, 582) = 3.92, p = .009, \eta_p^2 = .02$ , and practice condition,  $F(1, 582) = 75.29, p < .001, \eta_p^2 = .12$ . These main effects were qualified by interactions between grade and country,  $F(3, 582) = 5.95, p = .001, \eta_p^2 = .03$ , and between grade and practice condition,  $F(1, 582) = 14.91, p < .001, \eta_p^2 = .03$ . (See Figure 4.)



**Figure 4.** Use of base-10 canonical representations: Effects of grade, country, and condition

The effect of grade reflected our previous observation: kindergartners used canonical base-10 representations less frequently than first-graders (confirmed by pairwise comparisons by grade within each country, using Bonferroni correction, all  $p$ 's  $< .05$ ). The *interaction between grade and country* was further investigated with tests of simple effects. The results showed no significant differences across countries among kindergartners,  $F(3, 264) = 1.70, p = .17, \eta_p^2 = .01$ , but a significant

difference among first-graders,  $F(3, 318) = 10.15, p < .001, \eta_p^2 = .10$ . To examine differences among first-graders by country, we conducted pairwise comparisons using the LSD method. The results showed that the effect of country was driven by Russian first-graders, who used canonical base-10 representations less frequently than their peers in other countries, who were not different from each other. The *interaction between grade and practice condition* was examined with tests of simple effects. They showed a more frequent use of base-10 canonical representations after mixed-digit practice compared to single-digit practice in both grades, but the effect was more pronounced among kindergartners,  $F(1, 264) = 73.57, p < .001, \eta_p^2 = .20$ , than among first-graders,  $F(1, 318) = 12.48, p < .001, \eta_p^2 = .05$ .

In sum, the findings most relevant to our research questions indicated that: (a) kindergartners showed no differences across countries; (b) American first-graders performed comparably to peers from Taiwan and South Korea, whereas Russian first-graders used base-10 representations less frequently; and (c) practice affected performance in both grades, but most strongly in kindergarten.

**Patterns of performance with different numeric magnitudes.** To examine how students' performance varied with the target number, we conducted a  $5$  (Number)  $\times 2$  (Grade)  $\times 4$  (Country) ANOVA, with the percentage of canonical base-10 strategies as the dependent variable. We found significant effects of number,  $F(4, 590) = 18.4, p < .001, \eta_p^2 = .03$ , and grade,  $F(1, 590) = 138.3, p < .001, \eta_p^2 = .19$ , as well as an interaction between them,  $F(4, 590) = 13.5, p < .001, \eta_p^2 = .02$ . Simple effects tests revealed that target number did not affect the use of base-10 representations in first-graders,  $F(4, 322) = .60, p = .66, \eta_p^2 = .003$ . In contrast, it impacted the performance of kindergarten students,  $F(4, 271) = 31.40, p < .001, \eta_p^2 = .07$ . The average frequency of using base-10 representations varied across target numbers in the kindergarten sample as follows: 62% of responses with "12", 59% with "16", 53% with "28", 46% with "34", and 43% with "61". Critically, country did not interact with number, so the overall pattern observed in kindergartners was the same across countries. For example, in the US sample, kindergarten students used base-10 representations on 59% of trials with "12" and 46% of trials with "61". In the Taiwanese sample, kindergartners used base-10 representations on 65% of trials with "12" and 42% of trials with "61". In summary, in all participating countries, the frequency of creating base-10 representations among kindergartners decreased as the magnitude of the target numbers increased.

## Discussion

The present study examined the early development of children's understanding of the base-10 number structure, which has been shown to play a significant role in their subsequent learning of mathematical concepts and procedures. To address this issue, we compared the use of base-10 representations by kindergartners and first-grade students from four countries. In contrast to the long-standing view that cross-national variability in math achievement may be due to language differences, such as the transparency of the base-10 structure in number words (Fuson & Kwon, 1992; Geary, Bow-Thomas, Liu & Siegler, 1996), we hypothesized that the differences may reflect variations in instructional emphases.

We tested this hypothesis in several ways. First, conducting the study 25 years after the original data were collected provided an opportunity to explore potential

changes in students, following a period of changes in math instruction. Second, examining performance of both first grade and kindergarten students provided another way of separating language and instructional effects by testing children who spoke the same language but differed in experience. Third, by varying practice conditions and the transparency of number words, we were able to further evaluate the extent to which performance was driven by language features versus children's experience with numbers.

### ***Changes in students' performance over time***

The striking changes observed in the responses of American first-graders on the number representation task, relative to earlier findings (Miura, 1987), indicate that performance on this task is sensitive to experiential factors. The last few decades in the US have witnessed an on-going debate about the goals of mathematical education (National Research Council, 1989; Schoenfeld, 2004). The debate has spurred substantial revisions of mathematics curriculum aimed at increasing instructional support for the development of conceptual understanding of numbers and numeric relations (National Council of Teachers of Mathematics, 1989, 2000, 2006). Our results suggest that changes in curricular content that have occurred during the last decades may have contributed to changes in children's thinking about the base-10 structure of multi-digit numbers.

To be clear, we are not making general claims about the quality of American math education. Our analyses focused on a specific aspect of conceptual development in the early school years. Our participants were not representative of the entire student population—as in the earlier studies, they were from well-educated professional families. Further, as the math curriculum in the United States is determined by local school districts within broad state guidelines, the experience of our participants may differ from that of other students in the country. We would argue, however, that this does not pose a challenge with respect to our goal of evaluating the role of instruction, in comparison to language, in the development of numeric representations. Uncovering changes in American students that have occurred over time is directly relevant to this goal. Our findings indicate that English-speaking first-graders are able to perform equivalently to speakers of more transparent languages when representing the base-10 structure of numbers, even though past studies revealed a different pattern of performance.

### ***First-graders' use of base-10 representations across four countries***

In all participating countries, first grade students were highly accurate in naming two-digit numbers and representing them with unit- and ten-blocks. Further, first-graders most often represented numbers using the canonical base-10 strategy. Thus, by the time of the study, these students had developed a high level of understanding of the base-10 structure of two-digit numbers. The language-based prediction (whereby Korean and Taiwanese children would produce base-10 representations more frequently than American and Russian students) was not supported by the data: American students did not differ from their Asian peers in this regard. The one group that differed from the others was Russian first-graders, who used base-10 representations less frequently (although it was still the prevalent way of representing numbers), which could be due to differences in math instruction.

Although a detailed curriculum analysis was outside the scope of this paper, our examination of curricular guidelines and instructional materials led us to make some observations. We found that in those schools from which Russian participants were recruited, the instructional emphasis in the first half of the year was primarily on the development of computational skills within 10, and then within 20. Most activities involved arithmetic exercises and computational word problems, although there were also some measurement activities that could have promoted the understanding of base-10 structure, such as conversion of centimeters into decimeters (e.g.,  $14\text{ cm} = 1\text{ dm} + 4\text{ cm}$ ). The Russian teachers indicated that the bulk of activities that focus directly on the structure of two-digit numbers and place value usually follow the period when initial computation skills are established. If our study had compared the ability to solve word problems across participating countries, it is quite likely that the Russian first-graders would have shown the highest level of performance. But since the study compared the use of base-10 representations, for which Russian participants had received less instruction at the beginning of first grade, it is not surprising that their use of such representations was somewhat less frequent.

The experience of study participants from the other three countries was different in that a major emphasis of early instruction was on the systematic understanding of single- and two-digit numbers, including their magnitude and place value. Toward this goal, teachers used a variety of activities. For example, we observed American students in some of the classrooms counting how many days had passed since the start of the school year. On the first day, students put a straw in the “ones” pocket on the wall display. They continued adding straws daily until arriving at 10, at which point the straws were bundled together and placed in the “tens” pocket. This and other activities were clearly designed to facilitate the understanding of the base-10 numeric structure.

A potential concern could be that if some of these activities included unit- and ten-blocks, the students in our study may have used them mechanically to reproduce what they did in class. We determined that some first-graders were indeed exposed to manipulatives similar (but not identical) to the ones included in this study. However, this factor alone did not appear to predict the frequency of base-10 representations. Taiwanese teachers reported using these materials, Korean teachers did not use them at all, and American teachers differed in this respect, yet their students showed statistically equivalent results.

### ***Development of number representations in kindergarten students***

Given that first-graders had some instructional activities involving two-digit numbers, we were particularly interested in determining whether kindergartners would show differences in number representations consistent with the linguistic explanation. These children arguably had more limited practice with two-digit numbers than first-graders (although they still might have diverse numeric experiences through parental input or earlier instruction). Our examination of curriculum guidelines and interviews with teachers indicated that instructional activities involving two-digit numbers were not introduced until first grade in all participating countries. Kindergartners were expected to recognize two-digit numbers and include them in their counting routines, but there was no class instruction on place value (tens and ones), and no activities that required decomposing two-digit numbers into tens and ones.



**Lack of cross-national differences.** Our results confirmed kindergarten students' familiarity with two-digit numbers, as they were highly accurate in naming them. At the same time, kindergartners used base-10 representations less frequently than first-graders—the pattern seen in all four countries. Critically, there were no significant differences in the use of base-10 representations among kindergartners across countries, despite the fact that they were familiar with the required numeric language and the languages varied in transparency of the base-10 structure. The lack of differences by country cannot be explained by a floor effect, because kindergartners produced base-10 representations on about half of the trials, with substantial variability within each country. In fact, the use of these representations did vary systematically, albeit not as a function of language, but as a function of practice condition and target number.

**Practice effects.** Like first-graders, kindergartners used more base-10 representations following mixed-digit, compared to single-digit, practice. The effect was even stronger in kindergarten students, indicating that they were particularly influenced by observing the use of a ten-block during practice. A possible explanation of the practice effect is that it reflected imitation rather than a genuine understanding of base-10 structure. However, we believe this explanation is unlikely. Only a small percentage of students (1.3%) seemed to use ten-blocks to imitate the experimenter: They produced single-unit collections combined with a ten-block (e.g.,  $12 = 12$  unit-blocks + 1 ten-block,  $34 = 34$  unit-blocks + 1 ten-block) on multiple trials. Yet the majority of students who used base-10 representations did so in a meaningful way, choosing the appropriate number of ten-blocks, rather than mechanically reproducing the use of one ten-block, as observed in practice. Our findings are consistent with those of Saxton and Towse (1998), who also concluded that an increased use of base-10 representations following a mixed-digit practice is not attributable to imitation.

To offer a possible explanation for the observed effect of practice, we turn to Siegler's overlapping waves theory, which posits that at any given time, children have multiple ways of thinking about a problem (Siegler, 1996). They select among possible approaches based on their prior experience and the likelihood that a given approach will efficiently lead to an accurate response (Shrager & Siegler, 1998). In this context, some kindergartners and most first-graders may have access to different ways of representing numbers, including single unit collections and a more efficient base-10 representation. The latter may become more prominent as children gain experience with two-digit numbers, leading them to a better understanding of underlying numeric structure. When the base-10 representation is a predominant way of thinking about numbers, children may use it spontaneously, regardless of whether it was used by the experimenter. However, at the earlier stages of forming a base-10 representation, children may require additional support to select it. This may explain why in the present study kindergartners across the four countries relied on such support more than first-graders.

**Number effects.** Variability in students' performance as a function of target number provided further evidence that the relative strength of particular representational strategies may depend on students' experience. We found that kindergartners in all four countries used base-10 representations more frequently with smaller numbers than with larger numbers. This result could not be explained by language features—in two languages (Mandarin and Korean) numbers did not vary

in the degree of transparency, and in the other two languages (English and Russian) larger numbers actually had a more transparent base-10 structure. Yet the amount of experience with target numbers most likely did vary in a way corresponding to the observed pattern (i.e., more experience with smaller numbers). It is possible that children develop base-10 representations in an incremental way, starting with familiar, smaller numbers. For example, counting objects may help them realize that a set of 10 items needs two more to make 12. Thus, in addition to unit representations that arise earlier from counting objects up to 10, a fledgling base-10 representation may emerge as a way of thinking about some two-digit numbers. As children's experience expands, they accumulate more exemplars of two-digit numbers, leading to a more general mental representation of their base-10 organization. If this is the case, children might acquire base-10 concepts incrementally, first with two-digit numbers and later with three-digit numbers, rather than acquiring it all at once—an issue that should be investigated in future work.

### **Limitations and future directions**

Converging evidence from different parts of our investigation indicates that instructional emphases (rather than, or in addition to, language factors) may play a critical role in the development of mathematical thinking. Yet, the present study did not involve a systematic observation of class instruction, which limited our ability to identify specific experiences that may promote the development of number representations in students. Our examination of curricular guidelines and informal interviews with teachers led to some speculation, but it would be important in future research to directly investigate the link between mathematical experiences and the development of this important aspect of numeric understanding. In particular, it might be useful to recruit Russian participants from schools using different curricular approaches to teaching early math. It should be noted that unlike 20 or 30 years ago, when the Russian educational system was guided by centralized policies, the current situation has become more decentralized, with school districts varying in the types of textbooks and curricular approaches. Based on the examination of the diverse instructional guidelines and the observation of classroom practices, researchers can formulate hypotheses as to which program is more likely to facilitate the development of numeric understanding. These hypotheses can then be tested by comparing performance on the base-10 tasks of students exposed to different curricula.

When comparing the performance of students receiving different types of instruction, it would be useful to expand the measures used to test children's mastery of base-10 concepts. The current investigation used only a block task. Future studies could examine this issue using a wider range of tasks, such as reading and writing multi-digit numbers. Examining correlations across a range of tasks, all of which require some understanding of the base-10 structure, will provide a more comprehensive picture of children's numeric knowledge.

Further, we recognize that our study focused on only one aspect of conceptual development, identified as an important part of the early foundation of mathematical learning. Clearly, there are numerous other concepts that children must develop, as well as procedural skills that should be mastered in order to solve math problems efficiently and accurately. Future studies focusing on specific aspects of conceptual development and procedural skills may allow investigators to pinpoint

the areas that require targeted revisions of curricular and instructional approaches to teaching mathematics. These studies would benefit from including children even younger than the participants in the present study, because the foundations of numeric knowledge start developing prior to kindergarten. When looking at younger children, one can investigate their emerging intuitive understanding of numbers and numeric relations. This knowledge may be instrumental in designing instructional practices that expand on children's early notions of number and lead to the development of a more sophisticated understanding of the numeric system.

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## DEVELOPMENTAL PSYCHOLOGY

### **Distinctive features of adolescent hardiness in families of different composition**

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This article analyzes the influence of family structure on the hardiness of adolescents aged 16-18 (average age 17.2). The aim was to investigate hardiness of subjects from full, single-parent, and large families. We used the Test of Hardiness Survey and the Noetic Orientations Test (SZhO). The sample comprised 200 subjects, first year university students from families with different compositions: 75 were brought up in a full family, 75 in a one-parent family, and 50 in a large family. A one-way analysis of variance and repeated measures MANCOVA showed that the subjects differ both in their hardiness and the distinctive features of its development. The authors conclude that subjects from full families are less hardy than those from single-parent families, but more hardy than those from large families. Also the hardiness dynamics of children from full, single-parent, and large families differ. Adolescents from single-parent families increase their hardiness further, whereas in students from full families it decreases. This can be explained by specific ways that the students survive the crisis of adolescence. And finally, students from large families demonstrate a similar level of hardiness in comparison with students from full families. This can also be explained by specific ways that they survive the crisis of adolescence. Later, when this crisis is almost over, their hardiness becomes similar to that of students from full families, which has decreased by that time.

**Keywords:** hardiness, commitment, control, challenge, family structure, adolescents

### **Introduction**

During the past 20 years, hardiness has been a subject of study by scientists internationally and in Russia. Although as M.V. Loginova (2010) has pointed out, there are many interpretations of hardiness (e.g., “survivability”, or “the courage to be” by P. Tillich et al.), in Russian psychology, the most empirically substantiated theory of hardiness is that of S. Maddi. According to his theory, hardiness is a pattern of attitudes and skills that, together, facilitate resilience under pressure by turning stressful circumstances from potential disasters into opportunities to grow in wis-



dom and performance. Hardiness consists of three attitudes: commitment, control, and challenge. Strong commitment refers to the belief that, no matter how bad things get, it is usually best to remain involved with the events and people in one's life, rather than to retreat into isolation and alienation. Strong control is the belief that, no matter how bad things get, it is worth continuing to try to effect outcomes, rather than retreating into powerlessness and passivity. Strong challenge is the belief that stressful changes are normal in life, and provide an opportunity to learn more, rather than being an inappropriate violation of one's right to easy comfort and security (Maddi et. al., 2009).

During the last 25 years, some investigations have touched on the problem of hardiness development and the factors that determine hardiness. Khoshaba and Maddi (1999) suggested that the roots of hardiness lie in youngsters' early experiences. They discussed the ideal condition for the development of hardiness as a nurturant period of childhood giving way to the more individualized development of adolescence, when youngsters must find their own way in a period marked by social and biological changes on an unprecedented scale for them. According to this hypothesis, in early life, persons who later became very hardy frequently experienced stressful changes and conflicts (for example, the emotional or physical absence of one or both parental figures, poverty, immigrant status, mental or physical illness of one or both parental figures). As a result, Khoshaba and Maddi conclude that it is not the mere fact of stressful circumstances in early life that contributes to the development of personal hardiness but, rather, the response to such circumstances in a compensatory manner by the family and the individual.

But this result was obtained in a group of adults. Some studies rely on data from teenager groups. For example, Hannah and Morrissey (1987), using a sample of adolescents, found that sex, age, religion, and the well-being of the family have strong correlations with hardiness. Shepperd and Kashani (1991), using a sample of adolescents, showed how hardiness, gender, and stress are interrelated. These variables can be a foundation for classification of teenagers' hardiness. Though there has been some research on the relation between adolescents' hardiness and their families (e.g., Walsh, 1996), very often other methods are used to study this phenomenon.

Bigbee (1992) tries to analyze the hardiness concept beyond the individual level. He emphasizes that, according to Maddi and Kobasa (1984), hardiness develops as a result of the family environment, so he explores the concept of hardiness from a family perspective, examining the effects of stressful life events on hardiness, and their effects on illness in families. In his view, "hardy families" are the result of hardy adult family members. But Bigbee does not analyze the hardiness of adolescents specifically, although in his study there are families with children under 18. Moreover he does not analyze non-married families, although his sample includes 10.4% such families.

Henry, Robinson and Wilson (2003) investigated how demography, family system, adolescent perceptions of parental behavior, and youth characteristics correlate with adolescent substance abuse. They tested a path model of specific factors within three levels of the family system in relation to substance abuse with a subsample of 214 high school students. Using this model, they studied family hardiness in different families (including single-parent families). According to their



definition, family hardiness describes the extent to which families feel a sense of control over life events. But family hardiness is not the same as hardiness as it is understood by Maddi, the authors did not identify distinctive features of family hardiness in different families.

Amerikaner, Monks, Wolfe, and Thomas (1994) investigated the relationships between individual psychological health (PH) and perceptions by young adults of family interaction and family climate. But though they described particular characteristics of young adults' hardiness, they did not consider families with different compositions.

Khodarahimi and Ogletree (2011) researched the hardiness of adolescents from different families and found that larger family size is related to less life satisfaction and special attention to emotions, and that having sisters may predict more negative outcomes than having brothers. Also, using the Ahwaz Hardiness Inventory (in the Farsi language), they found that family structure (including birth order) does not have a significant effect on hardiness. But the authors analyzed only large families and did not consider single-parent families.

Mirzaei and Kadivarzare (2014) studied the relationship between parenting styles and hardiness of high school students. They concluded that parenting styles play a significant role in hardiness, and that control is the key concept in both variables of parenting styles and hardiness. In authoritative and authoritarian parenting styles, the method of parenting is control. Control regulates intra-psychic processes and forms the control component of hardiness. Therefore it is essential to devise a special training method for parents to enhance the students' mental health.

Thus although some papers have shown that family structure affects the development of hardiness, no special research on this influence has been conducted. Our study is therefore aimed at revealing how family composition affects the hardiness of adolescents.

The specific hypotheses tested are:

- subjects from full families have greater hardiness than those from single-parent and large families;
- adolescents from full, single-parent, and large families demonstrate different dynamics of hardiness development.

## **Method**

### ***Participants***

In this cross-sectional study, we use a sample of teenagers aged 16–18 (average age 17.2) first-year students from families with different compositions. They were recruited from various departments of Irkutsk State University (journalism, psychology, physics, philology, law, and mathematics) by university newspaper announcements and bulletin boards. After selecting the participants, explaining the aims of the study, and securing their cooperation, we interviewed them to refine their family status. Then we reduced the sample to 200 participants: 75 from a full family, 75 from a one-parent family, and 50 from a large - family (three or more children). The number of boys and girls in all groups was equal, so the samples are representative with respect to demographic variables.

In the group of single-parent families we included families which were single-parent ones originally (64% of the sample) as well as those where divorce took place when the teenage subjects were children (36% of the sample). We did not take into consideration their siblings' gender and their birth order in large families, though in 74% of cases the subjects were the oldest children.

### ***Procedure***

We utilized the Test of Hardiness, which is the Personal Views Survey III-R by S. Maddi as adapted by D.A. Leontiev (Leontiev & Rasskazova, 2006). This consists of three dimensions: commitment, control, and challenge. The internal consistency of the total measure was 0.91 in the present sample, with 0.84 for commitment, 0.86 for control, and 0.89 for challenge. Commitment measures the extent to which individuals seek involvement rather than withdrawal; it contains a vital motivational quality that compels the individual to persist in pursuing a goal despite repeated obstacles, for example, "By working hard, you can always achieve your goal". Control deals with the extent to which individuals strive to exert control over their circumstances rather than feeling powerless. Perception of control or the degree to which a stressor is seen as under an individual's control are thus important in the appraisal of threat (e.g., "Most days, life is really interesting and exciting for me"). Challenge measures the extent to which individuals strive to learn from experience rather than feeling threatened (e.g. "My mistakes are usually difficult to correct").

We also used the Noetic Orientations Test (SZhO), an adaptation by D.A. Leontiev (2006) of J. Crumbaugh's and L. Maholic's Purpose-in-Life Test. The SZhO is a self-report attitudinal scale designed to measure the extent to which a respondent perceives a general sense of meaning and purpose in life, or conversely, suffers from an "existential vacuum". It consists of 20 items which focus on the respondent's mood (e.g., item 1: I am usually completely bored; neutral; exuberant; enthusiastic), 3 items addressed to life goals (e.g., item 3: In life I have no goals or aims at all; neutral; very clear goals and aims), and 3 items addressed to the meaning of life itself (e.g., item 4: My personal existence is utterly meaningless and without purpose; neutral; very purposeful and meaningful). Although Leontiev suggested 5 subscales, we used only the general scale of this test.

The data were analyzed using SPSS software. We used the independent two-sample t-test and dependent t-test for paired samples.

### ***Results***

The first step was to compare the hardiness of a single-parent family and a full family. Table 1 contrasts the mean values of each group. A one-way analysis of variance showed that the subjects from single-parent families demonstrated commitment more clearly than those from full families. The other scale data of the Test of Hardiness are also higher, but these differences are not significant. The use of a one-way analysis of variance let us see that all the differences between the subjects from full and single-parent families involved boys. While the girls from full and single-parent families did not demonstrate differences in their level of hardiness, the boys from single-parent families achieved higher scores on the scales for hardiness, control, and challenge.

**Table 1.** Contrast of the mean values of hardiness in single-parent and full families

	Variable	Mean Score		F	p
		Single-Parent Family	Full Family		
All	Commitment	34.43	31.57	4.45	0.01
	Control	31.34	29.76	1.05	0.31
	Challenge	16.52	16.20	0.29	0.69
	Hardiness	81.75	78.40	1.02	0.31
Boys	Commitment	36.89	33.26	2.54	0.11
	Control	35.26	29.01	8.90	0.00
	Challenge	18.16	15.65	4.60	0.03
	Hardiness	89.05	77.92	5.26	0.02
Girls	Commitment	32.56	33.90	0.35	0.56
	Control	28.36	28.49	0.01	0.94
	Challenge	15.28	16.80	1.86	0.18
	Hardiness	76.20	76.20	0.38	0.54

The second step was to compare the hardiness of a large family and that of a full family. It turned out that the subjects from large families demonstrated a much lower level of hardiness than the subjects from families with one or two children. A one-way analysis of variance showed that differences appeared on all scales: hardiness, commitment, control, challenge. As we mentioned earlier, the differences between the subjects from full and large families involve mainly girls. Girls from large families demonstrate higher levels of hardiness, commitment, control, and challenge than those from the other families.

**Table 2.** Contrast of the mean values of hardiness in large and full families

	Variable	Mean Score		F	p
		Full Family	Large Family		
All	Commitment	31.57	28.78	11.53	0.00
	Control	29.76	24.39	15.52	0.00
	Challenge	16.20	14.53	5.42	0.02
	Hardiness	78.40	67.97	13.93	0.00
Boys	Commitment	33.26	31.39	1.47	0.23
	Control	29.01	26.44	3.52	0.06
	Challenge	15.65	14.67	1.74	0.19
	Hardiness	77.92	72.50	2.75	0.10
Girls	Commitment	33.90	26.17	12.53	0.00
	Control	28.49	22.33	15.29	0.00
	Challenge	16.80	14.39	3.83	0.05
	Hardiness	76.20	63.44	13.53	0.00

So while the subjects from single-parent families demonstrated much greater expressiveness of such hardiness attitudes as commitment, those from large families, conversely, demonstrated less expressiveness of hardiness itself and all its attitudes. At the same time, for subjects from single-parent families, boys demonstrated all the differences, whereas for subjects from full families, all the differences were demonstrated by girls.

The third step was to analyze the dynamics of hardiness of all the subjects. Using a repeated measures MANCOVA, we compared the results achieved a year later, and found that the subjects from full families demonstrated significant differences only for commitment ( $F = 5.9$ ,  $p < 0.03$ ). The level of this attitude decreased (from 31.57 to 29.11). But additional analysis showed this difference only for girls; no changes took place with boys. On the contrary, the girls from single-parent families demonstrated a great increase of such attitudes as challenge, from 15.28 to 17.89 ( $F = 13.7$ ,  $p < 0.01$ ), and the boys did not demonstrate such results.

Thus the dynamics of hardiness and its attitudes are different for the subjects from full and single-parent families. We found a decrease of commitment in the girls from full families and an increase of such an attitude as challenge in the girls from single-parent families. The boys from both full and single-parent families did not demonstrate any differences in the level of hardiness and its attitudes.

The situation with the children from large families is different. According to a repeated measures MANCOVA one year later, they demonstrated a sharp increase on such scales of the Test of Hardiness as hardiness from 63.44 to 67.07 ( $F = 9.5$ ,  $p < 0.01$ ) and control from 22.33 to 24.54 ( $F = 7.4$ ,  $p < 0.02$ ). The scales of commitment and challenge also increased, though not so much. The second analysis of differences between the children from full and large families a year later did not demonstrate any significant differences between the samples.

Thus we can conclude that the hardiness dynamics of children from full, single-parent, and large families differ. Adolescents from single-parent families demonstrate a further increase in hardiness, and those from full families show a decrease.

And finally, the students from large families demonstrate a similar level of hardiness in comparison to the students from full families.

In the fourth stage, we analyzed the results of the SZhO test. First, we saw that the teenagers' results are in the statistical norm. A one-way analysis of variance showed that girls, in general, get a higher score on the SZhO than boys ( $F = 9.9$ ,  $p < 0.01$ ). But we did not find any difference between teenagers from a full family and those from a single-parent family, nor was there a difference between teenagers from full families and those from large families. This is of great interest, as there are stronger correlations between hardiness and its attitudes and the scales of the SZhO test (Kuzmin, 2012); but in this situation we could not find them.

## Discussion

We could not find many studies that set out to investigate how family composition affects hardiness. According to Khoshaba and Maddi (1999), it is not the mere fact of stressful circumstances (like the loss of mother or father, divorce, and so on) in early life that contributes to the development of personality hardiness, but rather the response of the family and the individual to such circumstances.

Also, according to the results of Mirzaei and Kadivarzare (2014), hardiness is determined by parenting styles (authoritarian first of all). We did not analyze the distinctive features of the response to the styles in single-parent families, but boys from single-parent families scored higher on such Hardiness Test scales as hardiness, control, and challenge. So, we can assume, after Khoshaba and Maddi (1999), that the situation in single-parent families pushes boys to “transcend the morass” (as Khoshaba and Maddi put it). Another possible explanation is that in single-families, as Khoshaba and Maddi suggested, parents attempt to convince the child that he or she has special abilities and talents that will lead to strength and achievement, whereas in full families the situation is different.

According to Khodarahimi and Ogletree (2011), larger family size is related to lower life satisfaction and special attention to emotions, whereas family structure (including birth order) does not have a significant effect on hardiness. We found that hardiness of adolescents from large families is expressed less than in those from full families. We believe that this phenomenon may be connected with the following: Khodarahimi and Ogletree used a sample of subjects aged 11–19, but our subjects were only 16–17, and differences in how the hardiness of subjects from full and large families was expressed applied only to subjects of this age. Later, at ages 17–18, the differences disappeared. We conclude that this reflects a difference in the dynamics of hardiness.

Moreover, we found out that girls from large families in comparison to those from other families demonstrated a greater difference on such scales as hardiness, commitment, control, and challenge. Khodarahimi and Ogletree (2011) do not address this question. We suggest that the majority of subjects from large families who participated in the investigation were elder siblings, and hence received less attention from their parents, and that this fact influences their hardiness level during the period of adolescent crisis. Later, when this crisis was almost over, their hardiness became equalized with that of the students from full families, which had decreased by that time. On the contrary, the hardiness of subjects from one-parent families seems to be the basis of their way of coping. That is why it increases over time.

## **Conclusion**

We conclude that the expressiveness of hardiness of adolescents from full, single-parent, and large families differs. Subjects from full families are less hardy than those from single-parent families, but more than those from large families. So the first hypothesis is partly confirmed.

The dynamics of hardiness of children from full, single-parent, and large families also differ. Adolescents from single-parent families demonstrate a further increase in hardiness, and students from full families show a decrease. This could be explained by their specific ways of surviving an adolescent crisis. And finally, teenagers from large families demonstrate a similar level of hardiness in comparison to students from full families. This could also be explained by their specific ways of surviving an adolescent crisis. Later, when this crisis was almost over, their hardiness became equalized with that of the students from full families, which had decreased by that time.

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## **Structural characteristics of the institutional environment for young children**

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The research literature suggests that institutions for children left without parental care do not provide environments that adequately promote children's development, and that characteristics of orphanages should be considered as an environmental factor influencing developmental difficulties in children living in institutions and later in post-institutional families. This study aimed to analyze the structural characteristics of the caregiving environment in two St. Petersburg (RF) orphanages—baby homes for children from birth to 4–5 years of age (BH A and BH B), and the maintenance of the structural interventions that were implemented in BH A during 2000–05 (The St. Petersburg–USA Orphanage Research Team, 2008). Both institutions belong to the Ministry of Health and are managed under the same medical regulations, providing about the same quality of medical care and nutrition. The results of the study show that the number of children living in each ward (4 to 6 in BH A and 5 to 8 in BH B), and the child–caregiver ratio (2 to 3 for BH A and 2.5 to 4 for BH B) in the two baby homes are about the same, while BH A have fewer staff members who are assigned to the ward (6–8 vs. 9–14 in BH B). The ward assistant teachers in BH A are assigned as the primary caregivers, working 5 days a week (39 hrs) vs. about 25 hrs a week for assistant teachers in BH B. While living in the baby home, children in BH A are integrated by age and disability (vs. segregation by age and partial disability integration in BH B), and are assigned to one ward (meaning the same caregivers, peers, rooms, etc.), while in BH B the children change their ward when they reach a certain age or developmental milestone (number of wards children experienced  $M(SD) = 1.1 (0.2)$  in BH A and  $2.7 (1.1)$  in BH B). Our results support the hypothesis that the structural characteristics of institutional environment in the two baby homes are different, and that in comparison with BH B, the structural characteristics of BH A show more caregiving stability and consistency. The results also show that the interventions implemented in BH A within the St. Petersburg–USA Orphanage Research Project were maintained for many years after the project was finished. The specific features of

an institutional caregiving environment should be taken into consideration in studies of the mental health and bio-behavioral development of children in institutions and post-institutional families.

**Keywords:** institutions, children, caregiving environment, stability, consistency

## Introduction

The research literature suggests that institutions for children left without parental care do not provide environments that adequately promote children's development (McCall et al., 2011; Rutter et al., 2010; The St. Petersburg–USA Orphanage Research Team, 2008; van IJzendoorn et al., 2011; Zeanah et al., 2009). Structural deficiencies of institutional environments are characterized by large numbers of children per ward (from 9 to 16+), high child–caregiver ratios (6–8+), the practice of dividing children into groups (either by age or by disability status) and frequent transitions to new wards (Bakermans-Kranenburg et al., 2012). Often the quality of caregiving in these institutions is extremely low: Caregiver–child interactions are infrequent, limited to routine caretaking activities, delayed, and caregiver-directed rather than responsive to children's actions, and are conducted in an impersonal manner (Groark et al., 2013; Muhamedrahimov, 2000). In a study of orphans in the Greek Metera Babies Center (Vorra et al., 2003), infants spent 17.5 hours in bed, indicating that for a major part of the day they had little opportunity to interact with a caregiver. Observations of caregivers with children from birth to 3 months and 3 to 10 months of age once a week from 9:30 am to 12:30 pm—including routine caregiving and “free time”—over a 2-month period documented the minimum amount of caregiver–child interactions in one St. Petersburg (Russian Federation) orphanage for infants (Muhamedrahimov, 2000). Across these two age groups, caregivers initiated interactions with the children approximately 10% of the total available time (approximately 18 min from 9:30 am to 12:30 pm). They responded to children's initiations of social interaction less than 1% of the time (less than 2 min); children cried for approximately 11 min before a caregiver responded; there was essentially no talking during more than half the time the caregivers were engaged in routine caregiving; and on average an individual child interacted with a caregiver for any reason for only approximately 12.4 min during any 3-hr. period and nearly half of this was associated with feeding. The social-emotional environment of infants and young children in these orphanages was characterized by severe deficits in the sensitivity, responsivity, and stability of the caregiving environment, as well as the neglect and maltreatment of the children.

Overall, institutions can be differentiated according to the severity of deprivation. Certain institutions can be categorized as “globally depriving institutions” that do not provide children with adequate medical care, nutrition, or sanitation (Gunnar, 2001). Psycho-social conditions in such institutions are very poor, since children spend most of the time in their cribs, do not have enough stimulation, and one-to-one interaction with caregivers is very rare. In “social-emotionally depriving institutions,” children have adequate medical care and nutrition, but caregivers are business-like when performing routine caretaking activities and do not provide much interaction with children (Gunnar, 2001; The St. Petersburg–USA

Orphanage Research Team, 2008). According to the results of the quasi-experimental intervention study, the structural characteristics of institutions for infants and young children was shown to be critical for the positive development of children in orphanages. Specifically, the double intervention program was designed to provide structural changes (by assigning two primary caregivers to smaller age- and disability-integrated groups, terminating transitions of children to new wards, and establishing a "Family Hour" for primary caregivers to be with their children), coupled with staff training (emphasizing sensitive and responsive caregiver-child interactions); it showed better developmental outcomes for children as compared with the intervention program implementing staff training only (Muhamedrahimov et al., 2004; The St. Petersburg-USA Orphanage Research Team, 2008).

A considerable number of studies have shown that children reared in institutions are at substantial risk in various domains of functioning, including their physical, cognitive, and general behavioral development (Bakermans-Kranenburg et al., 2012; The St. Petersburg-USA Orphanage Research Team, 2008; van Ijzendoorn et al., 2011). Those with a substantial history of institutional care (IC) (~1–2 years) display a variety of long-term neurological, physical, cognitive, behavioral, and social-emotional difficulties (Nelson et al., 2011; Rutter et al., 2010). These adverse developmental outcomes in institutionalized children might be produced by other confounding risk factors, such as genetic or prenatal conditions, birth complications, or negative pre-orphanage experiences (Bakermans-Kranenburg et al., 2012; van Ijzendoorn et al., 2011). The literature cited above suggests that characteristics of institutions should be considered as an environmental factor influencing developmental difficulties in children living in institutions and later in post-institutional families. The aim of this work was to study the caregiving environments in St. Petersburg orphanages for infants and young children, including in the orphanage in which the intervention program (structural changes coupled with staff training) was implemented during 2000–05 (The St. Petersburg-USA Orphanage Research Team, 2008). The differences in the structural characteristics of these orphanages will be analyzed. It was assumed that the structural interventions implemented in one of the orphanages by the St. Petersburg-USA Orphanage Research Project were maintained by the orphanage personnel for many years after the project was finished, and that even those orphanages that belong to the same system of institutions would be different in their structural characteristics, namely in the stability and consistency of the institutional environment.

## Method

### *Participants*

*Baby Homes.* Two institutions (baby homes, BH) located in St. Petersburg, Russian Federation, for children approximately 0 to 4–5 years of age left without parental care, participated in this study. These institutions are administered by the Russian Federation Ministry of Health and the local district administration, and were selected because their directors (head pediatricians) were willing to participate in the study, and they were relatively good institutions, providing adequate medical care and nutrition. Children arrive at the BH at various ages, but mostly in the first few months of life, either directly from the hospital where they were born or another

hospital, or after spending a few months with their birth families. They were relinquished by their biological parents for a variety of reasons, including financial and behavioral inability to rear the child. Caregivers in the BH are all females with some training in health and education (The St. Petersburg–USA Orphanage Research Team, 2008).

In the first baby home (BH A), caregivers were trained in an intervention program by the St. Petersburg–USA Orphanage Research Project during 2000–05 (The St. Petersburg–USA Orphanage Research Team, 2008) to engage in sensitive and responsive interactions with children. Structural changes were also implemented in the institution, including a reduction in group size, the assignment of permanent primary caregivers to each group, age and disability integration of children, and no transitions of children to new wards. The second baby home (BH B) offers the same quality of medical care and nutrition for children as BH A, but for the staff and children of BH B the research project was a new experience; no intervention was provided and BH B had not been part of the St. Petersburg Orphanage Research Project.

*Children.* Environmental characteristics of the group of 119 children aged from birth to 5 years from the two baby homes (60 from BH A and 59 from BH B) were taken into consideration in the analysis of the general structural characteristics of each institutional environment. A group of 69 institutionalized children participated in the study of the number of wards and transitions that the children had experienced. Thirty-eight of them were from BH A (63.3% of the total number of 60 children at that baby home) and 3 from BH B (52.5% of the total number of 59 children in BH B at the beginning of the study). The children's ages ranged from 5 to 60 months [ $M(SD) = 26.8(15.2)$ ], including 5 aged 60 months [ $M(SD) = 30.9(16.6)$ ] in BH A and 5 aged 46 months [ $M(SD) = 21.8(11.7)$ ] in BH B. In the total sample there were 38 boys and 31 girls (19/19 in BH A and 19/12 in BH B). Based on the baby homes' medical records, out of the total group of 69 children, 30 were characterized as typically developing (TD) (18 from BH A and 12 from BH B) and 39 were children with a special needs (SN) (20 and 19, respectively). Descriptive data for the different groups and subgroups of children from the two baby homes are presented in Table 1.

**Table 1.** Descriptive data on children from the two baby homes

Groups and Subgroups	BH A			BH B			BHs A & B		
	TD	SN	Total	TD	SN	Total	TD	SN	Total
N	18	20	38	12	19	31	30	39	69
Age range, months	5–57	8–60	5–60	6–34	5–46	5–46	5–57	5–60	5–60
Age $M(SD)$ , months	26.1 (14.9)	35.3 (17.1)	30.9 (16.6)	19.4 (10.1)	23.3 (12.7)	21.8 (11.7)	23.4 (13.4)	29.4 (16.1)	26.8 (15.2)
Gender, n (boys/girls)	7/11	12/8	19/19	9/3	10/9	19/12	16/14	22/17	38/31

*Note:* TD - typically developing children; SN - children with a special needs

## Assessments

Several structural components of the baby home environment were assessed to demonstrate differences in the caregiving stability/consistency for the children. Evaluation of the structural characteristics of the caregiving environment included the number of children in each baby home, the number of groups, group size, number of staff members working in the groups (assistant teachers, medical nurses, and nursery nurses), and an assignment of primary caregivers to each group, an implementation of age and disability integration of children in groups in contrast to the frequent transitioning of children between groups.

*Assessment of transitions.* A common practice in institutions is to have wards containing children of approximately the same age (e.g., infants, toddlers). Children are transitioned to older groups with new caregivers and older peers when they reach a certain age or developmental milestone (e.g., crawling, walking). In cases of infection, children also might be transferred for some period of time from the ward to a special medical treatment department at the baby home (the “isolation ward”) and/or from the baby home to a children’s hospital and back.

*Procedure.* In order to participate in the research project, an Institutional Agreement between each of the baby homes and St. Petersburg State University was drawn up and approved by both administrations. The baby home records were used to understand the staff employment and working schedules, as well as caregiver and children assignments. The project systematized the recording process by creating a set of checklists, which were tested, optimized, and implemented, and the data collection process was established.

Information about the structural characteristics of the baby home environment was extracted from official baby home documents, including employment and records on distribution of caregivers and children to groups for the period of September–December, 2014. Data on children’s age and disability status were based on the baby home’s medical records. The group records were used to determine whether children with different ages and disabilities were assigned to a group. The baby home kept records of children’s transitions to new wards, from wards to the isolation ward, and to hospitals and back. These records were used to calculate the number of transitions each child had experienced before the research project started. The project systematized the recording process by creating a checklist of transitions to be filled in for each child by the baby home pediatricians.

## Results

*General information on structural characteristics of each institutional environment.* At the beginning of the study, BH B housed 59 and BH A housed 60 children from birth to 5 years of age, placed into 8 and 12 wards, respectively (see Table 2). The number of wards in BH B included the isolation medical ward which was also used for long-term housing, while the isolation ward in BH A was used for the short-term observation of newly arrived children and the treatment of sick children. For the period of observation (September–December 2014), the number of children living in each ward (group size) varied from 5 to 8 in BH B and from 4 to 6 in BH A. Children in BH B were assigned to different wards according to age; children

with severe disabilities lived for long periods of time in the isolation medical ward (children 0 to 5 years of age) and/or in the special ward for disabled children (from 1 to 5 years of age). At BH B, there are two wards for children aged 0 to 7 months, one for children aged 7 to 18 months, one for children aged 1.5 to 2.5 years, and two for children aged 2.5 to 4 years; there is no age integration. The last ward included typically developing children and children with disabilities. Children in BH B are transitioned to other wards with new caregivers and older peers when they reach a certain age or developmental milestone. All groups in BH A are integrated by age and disability and there are practically no transitions from one ward to another.

Routine care in both baby homes is provided by caregivers who work on the wards with the children. In both baby homes this includes medical nurses (MN) who work a 24-hr shift once every 4 days (4–5 MN per ward, 1 per shift; and in the BH B isolation medical ward there are 10 MN, 2 per shift), as well as assistant teachers. In BH B assistant teachers (AT) (3–4 per ward, 2 during the day with one working from 8 a.m. to 2 p.m. and the other from 2 p.m. to 8 p.m.) work in a shift for about 25 hrs a week; there are no ATs in the BH B isolation ward.

In each of the BH A wards, 2 ATs are assigned as primary caregivers (plus 1 AT in case of substitutions) working 5 days a week for 39 hrs a week (2 days for 7 hrs a day from 7:30 a.m. to 2:30 p.m., 2 days for 6 hrs a day from 2:30 p.m. to 8:30 p.m., and 1 day for 13 hrs from 7:30 a.m. to 8:30 p.m.). The nursery nurses are assigned to each group in BH B (2–5 per group, 1 during the day), while this position was eliminated in BH A. Depending on the group, the total number of caregivers who work with the children in each of the wards varies from 9 to 14 (4 during the day) in BH B, and from 6 to 8 (3 during the day) in BH A (see Table 2). Even when two caregivers are working on the ward, the child–caregiver ratio varies depending on the group, from 2.5 to 4 for BH B, and from 2 to 3 for BH A.

**Table 2.** Structural characteristics of institutional environment in two baby homes

Baby Home Characteristics		BH A	BH B
Number of children		60	59
Number of wards		12	8
Ward size		4–6	5–8
Number of staff members per ward (total / during the day)	assistant teachers	3–4 / 2	2–3 / 2
	medical nurses	4–5 / 1	4–5 / 1
	nursery nurses	2–5 / 1	No
	total staff in ward	9–14 / 4	6–8 / 3
Primary caregivers assigned		Yes	No
Age integration		Yes	No
Disability integration		Yes	Partly
Transition to new wards		No	Yes

*Number of wards the children experienced.* Comparisons revealed a significant difference in the number of wards to which children were assigned in BH A and in BH B for the total number of children [ $\chi^2(4, N=69)=45.2, p<.001$ ], and for all subgroups: for typically developing children (TD) [ $\chi^2(3, N=30)=19.4, p<.001$ ],



and for children with special needs (SN) [ $\chi^2(4, N=39)=25.6, p<.001$ ] (see Table 3). Our results show that children in BH B were assigned to a greater number of wards [for different subgroups, number of wards  $M(SD)=2.6(1.0)$  to  $2.8(1.1)$ ] than children in BH A [ $M(SD)=1.1(0.2)$ ].

*Number of transitions the children experienced.* Comparisons of the number of transitions children had experienced (including from one ward to another, from a ward to the isolation ward, from the baby home to a children's hospital and back) revealed a differentiation between BH A and BH B for the total group [ $M(SD)=3.9(3.0)$  in BH B and  $3.2(3.5)$  in BH A;  $\chi^2(10, N=69)=16.0, p=.099$ ], mostly because of differences for typical children (TD) [ $M(SD)=2.7(1.4)$  in BH B and  $1.4(1.5)$  in BH A;  $\chi^2(5, N=30)=10.7, p=.058$ ; Mann-Whitney  $U=58, p=.035$ ], but no statistical differences for children with special needs (see Table 3).

**Table 3.** Number of wards and transitions in two baby homes

Groups	N of Wards $M(SD)$ (Min–Max)		$\chi^2$ (df, N)	N of Transitions $M(SD)$ (Min–Max)		$\chi^2$ (df, N)
	BH A	BH B		BH A	BH B	
TD	1.1 (0.2) (1–2)	2.6 (1.0) (1–4)	19.4*** (3, 30)	1.4 (1.5) (0–5)	2.7 (1.4) (0–4)	10.7+ (5, 30)
SN	1.1 (0.2) (1–2)	2.8 (1.1) (1–5)	25.6*** (4, 39)	4.8 (4.1) (0–15)	4.7 (3.5) (0–14)	12.1 (10, 39)
Total	1.1 (0.2) (1–2)	2.7 (1.1) (1–5)	45.2*** (4, 69)	3.2 (3.5) (0–15)	3.9 (3.0) (0–14)	16.0+ (10, 69)

+ -  $p<.10$ ; \*\*\* -  $p<.001$

## Discussion

The research literature suggests that institutions for children left without parental care do not provide environments that adequately promote children's development (McCall et al., 2011; Rutter et al., 2010; The St. Petersburg–USA Orphanage Research Team, 2008; van IJzendoorn et al., 2011; Zeanah et al., 2009), and that characteristics of orphanages should be considered as an environmental factor influencing developmental difficulties in children living in institutions and later in post-institutional families.

This study aimed to analyze the structural characteristics of the caregiving environment in two St. Petersburg (RF) orphanages for infants and young children (baby homes). Since both of them belong to the Ministry of Health and are managed under the same medical regulations, they are assumed to have the same quality of medical care and nutrition for children. We hypothesized that although both baby homes belong to the same system of institutions, they will be different in their structural characteristics, namely in the stability and consistency of the institutional environment.

The study results show that wards in BH A, in comparison with wards in BH B, have fewer staff members who are assigned to the ward (6–8 vs. 9–14), including during the day (3 vs. 4). The ward assistant teachers in BH A are assigned as the primary caregivers, working 5 days a week for 39 hrs a week (vs. about 25 hrs a week for AT in BH B); wards in BH A were integrated by age and disability (vs. segregation by age and partial disability integration in BH B); and there are virtually no transitions of children from one ward to another in BH A (vs. many transitions in BH B). While living in the baby home, children in BH A are assigned to only one ward (meaning the same caregivers, peers, rooms, etc.), while in BH B the children change their living ward when they reach a certain age or developmental milestone (on average 2.7 wards for the total group of children from BH B). During the observation period, the group of typically developing children from BH A experienced fewer transitions and changes in the caregiving environment (including transitions from the group to the isolation ward, to a children's hospital and back) than those from BH B.

The results support the hypothesis that the structural characteristics of the institutional environment in the two baby homes are different, and that in comparison with BH B, the structural characteristics of BH A show more stability and consistency. The interventions implemented in BH A by the St. Petersburg–USA Orphanage Research Project (reduction in group size, assignment of permanent primary caregivers to each group, age and disability integration of children, and no transitions of children to new wards; see The St. Petersburg–USA Orphanage Research Team, 2008) were maintained for many years after the project was finished. The second baby home (BH B), which offers the same quality of medical care and nutrition for children as BH A, but at which no intervention was provided, could be described as a “social-emotionally depriving institution” (Julian, 2013; Merz & McCall, 2010), where children experienced low stability and consistency of the caregiving environment, and caregivers do not provide children the opportunity to interact and form attachment relationships.

During the period of observations in the two baby homes, the number of children in each was about the same, and the range of group sizes was similar, yet the caregiving stability and consistency were better for children in BH A. The daytime child–caregiver ratios in the wards of both baby homes were within about the same range (from 2.5 to 4 in BH B, and 2 to 3 in BH A), and indeed could promote developmental benefits for children, since the literature relates smaller group size to quality of care (NICHD Early Child Care Research Network, 2000), yet without stable and consistent caregivers, even the high caregiver–child ratio does not guarantee the adequate behavioral development of the children (Bamba & Haight, 2007).

In recent years, the state policy of the Russian Federation on caring for children without parental care has been largely directed at keeping children in their birth families, placing children in different types of substitute families, and improving the quality of care in institutions for children who reside there. New regulations on improving institutions (Resolution of the Government of the RF No. 481, May 24, 2014, Moscow) were influenced by the intervention project in the St. Petersburg baby homes. The new policies require that living conditions in institutions should

be close to several aspects of the family environment in the intervention. Specifically, group size should not exceed 6 for children up to 4 years and 8 for children over 4 years; groups should consist of children of different ages and disability status; the number of caregivers per group should be limited; and children should not be routinely transferred to new groups. Results of the study show that changes in institutional structure are needed in order to improve the caregiving environment for children who still live there.

## Conclusion

Although the baby homes of St. Petersburg (and the Russian Federation) are similar in number, age range, and the disability status of children, as well as in the number and structure of personnel, there may be substantial differences in the characteristics of their caregiving environments. Studies of the structure and quality of institutional environments suggest that the roots of developmental delays often seen in children with institutional experience are seeded in the quality of their early environments. Thus, improving these caregiving environments could encourage children's better mental and physical well-being. The specificity of the institutional environment should be taken into consideration in studies of the mental health and bio-behavioral development of children in institutions and post-institutional families.

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## Communication difficulties in teenagers with health impairments

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Contemporary psychological and pedagogical studies pay special attention to the socialization of physically impaired children, inclusive education and methods of providing such children with a safe environment to assist in their development. However, difficulties in interpersonal communication experienced by children with health impairments have remained beyond the research scope. The authors conducted a comparative analysis of communication difficulties in typically developed teenagers aged 12-13 years ( $n = 100$ ) and the problems faced by their peers with visual ( $n = 30$ ), auditory ( $n = 30$ ), speech ( $n = 25$ ) and motor ( $n = 15$ ) impairments. Actual communication difficulties in teenagers were studied in two ways: the subjective component of impaired communication was registered through a content analysis of a sentence completion test and the objective manifestations of impaired communication were identified through expert evaluation of children's communicative behavior (educators and psychologists who had been in close contact with the teenagers acted as experts).

First, the authors identified typical standard communication problems that were characteristic of teenagers aged 12-13 years, that is, problems with aggression, tolerance, the ability to admit wrongdoing and make concessions, empathy, self-control, self-analysis and self-expression in communication. Second, typical communication difficulties characteristic of physically impaired children were revealed: failure to understand meaning; feelings of awkwardness and shame of oneself; expectations of a negative attitude toward oneself; gelotophobia; and manifestations of despotism, petulance and egotism as defensive reactions in situations of impaired communication. Third, the authors described specific communication difficulties in teenagers with auditory, visual, speech and motor impairments.

**Keywords:** impaired communication, communication difficulties, health impairments, teenagers, objective component of impaired communication, subjective emotional experiences

### Introduction

Currently, the issue of *impaired communication in children* is becoming more and more acute. These days, 79% of children and teenagers perceive interpersonal com-

municative situations as demanding, stressful, difficult, and requiring serious effort and coping skills. Many children and teens develop a fear of close relationships and a need to reduce face-to-face communication to a minimum while substituting interpersonal contact with online communication, gaming and addictive behavior (Samokhvalova, 2015). However, only the natural environment of a communication context enables children to adapt to life in society, obtain the experience of interpersonal dialogue, and learn self-assertiveness and self-expression through communication.

Children's inability to realize and overcome emerging communication difficulties hinders their development as communication agents, deforms self-identity and destroys interpersonal relationships.

Numerous findings by both foreign and Russian psychologists (MacDonald & Carroll, 1992; Bronfenbrenner & Morris 1998; Allard & Williams, 2008; McCormack, Harrison, McLeod, & McAllister, 2011; McLeod, Daniel, & Barr, 2013; Larkin, Williams, & Blaggan, 2013; Kunitsyna, 1991; Bodalev & Kovalev, 1992; Labunskaya, Mendzheritskaya, & Breus, 2001 et al.) confirm the specific psychological phenomenon of impaired communication. The term "impaired communication" covers not only speech disorders but also a wide range of linguistic, clinical, social and psychological manifestations that result in inappropriate, dysfunctional, impaired, problematic, uncomfortable and ineffective communication (Labunskaya, Mendzheritskaya, & Breus, 2001).

Post-nonclassical psychology, characterized by multiple interpretations of psychological terms and definitions (Martsinkovskaya, 2012), fails to offer a consistent scientific framework to define impaired personal communication; the difference between the terms "destructive communication", "deficient communication", "impaired communication" and "deformed communication" is either vague or imperceptible.

Personality psychology studies deficient communication associated with the subjective emotional experiences of socially isolated people (Weiss, 1973; Zilburg, 2000; Abulkhanova, 2007; Kunitsyna, 2009 et al.) and identifies the psychological features of loneliness, which has a destructive influence on teenagers and adolescents (Kon, 2003; Slobodchikov, 2012; Shagivaleeva, 2014 et al.).

Social psychology studies destructive communication resulting from and leading to disharmony in interpersonal relationships and mutual interactions (Richardson, 2009; Wilson, 2012; Levitov, 2013; Dotsenko, 2015 et al.). Developmental psychology also studies destructive communication, found in children and teenagers, which results mainly in aggression and tendencies toward conflict (Andrienko, 2010; Gerbeev, 2011; Belicheva, 2013 et al.). Such behavior patterns are also a topic of study in childhood social psychology, which focuses on "street kids" and criminal teenage subcultures (Yenikolopov, 2011; Rean, 2012 et al.).

Clinical Psychology and Special Education identifies communication impairments resulting from a child's ontogenesis (Narayan, 2011; Mersal, 2013; Yankova, 2008; Gorkovaya, 2015; Shipitsyna, 2012; Zaschirinskaya, 2014 et al.) and studies communication problems in children with emotional and conative impairments (Morozov, 2012; Nikolskaya, 2014) and mental retardation (Artemyeva, 2009; Gabueva, 2011; Karpova, 2014 et al.).



In stress-coping studies, deformed communication is considered to be caused by communication stress (Bodrov, 2006; Kitaev-Smyk, 2009; Kryukova, 2010; Sergienko, 2008; Kuftyak, 2011; Saporovskaya, 2013).

The issues of personal impaired communication are a field of study in social psychology and developmental psychology. The Western psychological tradition defines impaired communication as communication disorders (Larkin, Williams, & Blaggan, 2013; Kim & Lombardino, 2013; Bruce, Braidwood, & Newton, 2013), violations of connections in “multi-personal systems” (Barr, McLeod, & Daniel, 2008; McCormack, Harrison, McAllister, & McLeod, 2011), or effects of risk factors (Risikofaktors) that increase the level of children’s maladjustment to the social environment (Holtmann, Becker, Kentner-Figura, & Schmidt, 2004; Petermann, Niebank, & Scheithauer, 2000).

Psychological studies in Russia also fail to provide a common approach to the definition of impaired communication; it may be regarded as a consequence of communicative incompetence (Arzhakaeva, 1995; Cabrin, 2005; Lozovan, 2005; Petrovskaya, 2007; Sidorenko, 2008 et al.), a result of subjective emotional experiences (Kunitsyna, 1991; Kan-Kalik, 1995; Parigin, 2003; Yushachkova, 2006), or a merger of subjective emotional experiences and objective communication difficulties (Bodalev, 1992; Kuzmina, 2004; Labunskaya, Mendzheritskya, & Breus, 2001; Kazanskaya, 2012).

The authors regard *impaired communication in children* as an integrated psychological process that takes place when, due to the actual communication level, a person fails to find an effective solution to a communication task without resorting to additional resources, which leads to a variety of communication difficulties and determines the nature of children’s interactions (Samokhvalova, 2015).

This research is based on the views of V.N. Kunitsyna, who identified the psychological and process-related aspects of impaired communication (Kunitsyna, 1991). The authors study both *the subjective component*, which manifests itself through negative inner emotional experiences, contradictions and teenage communication complexes, and the *objective component* of impaired communication, which emerges as the destructive influence of evident communication impairments on interlocutors.

The major feature of impaired communication is communication difficulties that arise in personal interaction. These difficulties are defined as subjectively perceived barriers to communication. The barriers overthrow the inner balance of interlocutors, which worsens interpersonal relationships and requires additional inner effort from interlocutors to overcome these barriers.

The *classification of communication difficulties* includes four categories:

- *Basic communication difficulties* are those of empathy and contact-making. They include difficulties related to children’s egocentrism and the absence of positive attitudes to another person, inadequate self-esteem, an excessive emotional addiction to an interlocutor.
- *Content-related communication difficulties* are those that stem from a lack of communicative knowledge and the inability to forecast, plan, control or adjust the communicative strategy.
- *Instrumental communication difficulties* are manifested through the child’s inability to implement planned communication strategies in an effective

way. These difficulties can be verbal, non-verbal, prosodic, extralinguistic or strategy-related.

- *Reflective communication difficulties* include problems of self-reflection, self-analysis and self-evolution (Samokhvalova, 2011).

*Children with health impairments* are hit hardest in regard to communication difficulties. For such children, various interpersonal communication disorders are extremely dangerous, as they hinder socialization and restrict adaptive and communicative abilities. According to several authors, children with health impairments live under *constant pressure* (Aisherwood, 2010; Fourie, 2011). As early as preschool age, such children gradually realize that they are “different from others”, that they are often laughed at or shunned. They are always on the alert, which provides them with compensatory adaptive defenses. Their interpersonal communication is often characterized by defensive behavior aimed at self-protection and disguising their impairments (Aisherwood, 2010). That is why stress, related to physiological deficiency, is aggravated by interpersonal communicative situations.

Social and psychological care for children with health impairments in Russia aims mainly to provide such children with a proper education, whereas their personal fulfilment in interpersonal communication is often neglected. Parents of physically impaired children are also unable to provide them with adequate assistance in overcoming communication difficulties due to a lack of specialized knowledge and competencies. Therefore, children attempt to solve communication problems on their own, and as their abilities to do so are limited, they perceive the world as “alien” and “hostile” (Zashhirinskaja, 2013). Situations of impaired communication accumulate negative communication experiences, add to the development of psychological complexes and loneliness, bring about destructive coping strategies (Kryukova, 2010), and destroy psychological independence and personal emotional stability (Nartova-Bochaver, 2015). That is why it is essential to identify communication difficulties in physically impaired children and provide them with personalized psychological care and assistance in their interactions.

## Method

### *Design*

The authors aim to verify the following *hypothesis*: along with communication problems typical of the age group in general, teenagers with health impairments have specific communication problems that differ from those of their conditionally healthy peers. These specific problems cause negative emotional experiences and inferiority complexes; they hinder constructive self-expression and self-actualization in interpersonal relationships among children.

The paper describes the findings of comparative studies of communication problems in physically impaired and conditionally healthy teenagers. The teenagers were divided into four groups according to their impairment: auditory, visual, speech and motor. First, each group of physically impaired children was compared with the control group, which consisted of typically developing peers (Mann-Whitney U-test). The experimental and control groups were similar in the number of respondents, gender and age. Then, the four groups of physically impaired children

were cross-compared with each other to identify specific communication difficulties in physically impaired teenagers (Kruskal-Wallis test).

The empirical data were processed with the SPSS V.19.0 package. The differences between the group profiles on separate communication variables were identified with Mann-Whitney U-test and Kruskal-Wallis test. The teenagers' statements on their subjective emotional experiences in impaired communicative situations were analyzed for content with the help of Fisher angular transformation  $\varphi^*$ .

### **Participants**

Two hundred (200) teenagers aged 12-13 participated in the research. Of those, 100 were physically impaired children with intact intellectual faculties and without any experience of inclusive education; they lived with their families and had attended municipal closed specialized schools since the first grade. The groups were as follows:

Group 1 — teenagers with *visual* impairments, namely, moderate and high myopia ( $n=30$ , 18 girls and 12 boys studying in a specialized boarding school for visually impaired children);

Group 2 — teenagers with *auditory* impairments, i.e., neurosensory hearing loss, Degree II and III ( $n=30$ , 11 girls and 19 boys from a specialized boarding school for children with auditory impairments);

Group 3 — teenagers with *speech* impairments, namely, uncomplicated cases of general speech underdevelopment manifesting itself in underdeveloped phonetic and semantic aspects of speech, dysgraphia or dyslexia typical of the second and third degrees of speech development ( $n=25$ , 10 girls and 15 boys studying in a boarding school for children with speech and motor impairments);

Group 4 — teenagers with *motor* impairments, namely, infantile cerebral paralysis ( $n=15$ , 6 girls and 9 boys studying in a boarding school for children with speech and motor impairments).

The four control groups included 100 conditionally healthy teenagers aged 12-13, living with their families and attending municipal comprehensive schools without the experience of inclusive education ( $n_1=30$ , 18 girls and 12 boys;  $n_2=30$ , 11 girls and 19 boys;  $n_3=25$ , 10 girls and 15 boys;  $n_4=15$ , 6 girls and 9 boys).

The teenagers' parents gave their voluntary consent for the participation of their children in the research. The parents demonstrated considerable interest in obtaining recommendations on the optimal ways to communicate with physically impaired children. The teenagers participated in the research voluntarily. The empirical data were coded; the research was ecological and met the requirements of anonymity and confidentiality.

### **Measurements**

#### *Expert evaluation of children's communicative behavior*

This method of summarizing independent evaluations was used to identify *the objective component of impaired communication*. It enabled the recording of the level of teenagers' communicative skills and the identification of their actual communication difficulties (Samokhvalova, 2011). The experts were adults — psychologists, teachers, and social counselors of specialized and comprehensive

schools — who knew the children well and had the ability to meet with them on a daily basis. In each part of the research, the opinions of four experts were taken into account.

Experts performed standard observations of teenagers' communicative manifestations in potentially difficult communicative situations, giving each participant points in accordance with certain criteria and registering these points. The observations were carried out in various situational contexts, which fell into two categories.

1. *Communication with peers*: situations of interpersonal conflicts with peers, situations of meeting and cooperating with new people, situations of aggression from peers, situations of opposing the opinion of the majority, situations of standing up for one's opinion, situations of persuading peers, and situations of asking classmates for help.

2. *Communication with adults*: situations of dealing with comments from teachers or school administration and asking adults (teachers, psychologists) for help, situations of having to prove their opinion to adults, situations of admitting one's fault.

The chart included 16 basic items describing teenagers' communicative development, each of which was assessed on Likert scale from 1 to 5. The items were as follows:

- *basic items* included rapport, emotional generosity, readiness to help and to accept help, empathy, peacefulness;
- *content-related items* included the ability to plan interactions, communication adequacy, initiative, self-control in communication;
- *instrumental items* included the ability to cooperate, the ability to resolve a conflict, persuasive abilities, the ability to use communicative devices;
- *reflexive items* included the ability to analyze communication outcomes, the ability to accept and correct communication errors.

At the final stage of the research, after observing teenagers in different contexts of school life and extracurricular activities, each expert recorded the total points for each criterion of the teenager's communicative behavior. All the points given by experts were processed to calculate the average. The empirical data were verified for coherence and consistency. The final data were used to make *individual profiles of communicative behavior and actual communication difficulties*. Low and extremely low values for a particular item signified certain communication difficulties.

### *The projective method of incomplete sentences*

This method, based on the principles of projective research and content analysis (McAdams & Zeldow, 1993; Holaday, Smith, & Sherry, 2000), was used to identify *the subjective component of impaired communication*: inner negative emotional experiences in the teenagers, contradictions, or negative emotions the teens experienced while interacting with adults and peers. The obtained empirical data were subject to content analysis in four categories:

- importance of communication for the teenager;
- subjective reasons for impaired communication;

- objective causes of impaired communication, resulting from specific features of an interlocutor;
- desired methods of the teenager's communicative self-fulfillment.

The teenagers were asked to independently complete six sentences in writing with their own ideas, reflecting their thoughts, feelings or actions:

1. *To me, communication is...;*
2. *Sometimes I have difficulties in interactions, such as...;*
3. *Sometimes I find it difficult to interact with another person because I...;*
4. *I find it unpleasant to talk to a person who...;*
5. *I would like to get rid of some things that make communication difficult to me. They are...;*
6. *To get rid of my communication problems, I would like to learn....*

## Results

During the first stage in which empirical data were processed, each group of physically impaired children was compared with the control group, which had an equal number of participants. It was found that communication difficulties were more vividly observed in physically impaired teenagers ( $p \leq 0.002$  according to the Mann-Whitney test).

At the first stage, using the criterion of Kruskal-Wallis (this criterion enables the comparison of more than two groups), four groups of physically impaired children were compared to each other, which enabled us to identify specific communication difficulties in physically impaired teenagers.

### *Communication difficulties in visually impaired children*

The results of the expert evaluation of communicative behavior in visually impaired children demonstrated that the most essential problems for such teenagers are related to *entering the contact* ( $H = 27.262$ ,  $p = 0.004$ ). It took them a long time to scrutinize their interlocutor; they analyzed possible behavior patterns and were often lost in new conditions of communication. Other typical difficulties included empathy-related problems, i.e., the teenagers found it hard to understand the interlocutors' emotional state and target their communicative acts at them ( $H = 22.940$ ;  $p = 0.001$ ), and a lack of readiness to *accept help* from healthy children and unfamiliar adults, often perceived as "*strangers*" ( $H = 36.891$ ;  $p = 0.001$ ). In situations of impaired communication, teenagers often experience *self-control problems* ( $H = 20.035$ ;  $p = 0.002$ ); they are often annoyed, offended and can start crying and displaying inappropriate behavior. It is worth mentioning that they *do not admit their communication errors* ( $H = 23.543$ ;  $p = 0.003$ ); they are prone to self-justification and fantasies, which they often mistake for reality. This could be regarded as a defensive mechanism that enables teenagers to minimize the negative effects of the communicative situation.

The analysis of unfinished sentences showed that visually impaired teenagers often perceive the communication process as *a problem, challenge, and a way to carry one's point*. The most typically mentioned communication difficulties are *fear*

of *misunderstanding, anxiety, and shyness*. Their own disadvantages are *fast speech, low voice, and stubbornness*. Such teenagers sometimes consider themselves to be *cleverer than others*. They do not like to communicate with those who *shout and scold, make critical comments, hide something, and don't want to talk* or those who are *cheeky*. They dream of getting rid of *shyness*, learning to *command others*, and *speak loudly and beautifully*.

### *Communication difficulties in teenagers with auditory impairments*

In impaired communicative situations, *teenagers with auditory impairments* were prone to *verbal aggression* ( $H = 20.570$ ;  $p = 0.002$ ); their loud voice was accompanied by disruptive, chaotic non-verbal manifestations (gestures, face expression, extra-linguistic communicative devices). Such children were inclined to "attack" and suppress interlocutors, and if interlocutors objected, *protesting behavior patterns* were displayed ( $H = 25.163$ ,  $p = 0.002$ ). Such children are expressly individualist, autonomous, *unwilling to cooperate* with peers ( $H = 14.358$ ;  $p = -0.003$ ), and jealous of the results of their activities and of those adults with whom they have established contact. In interactions, they are often on the alert, anxious, and strained. They produce the impression of expecting an attack. In the authors' opinion, this is the cause of *communication inadequacy* ( $H = 30.144$ ;  $p = 0.001$ ) and defensive aggression.

Typical statements of teenagers with auditory impairments characterized communication as follows: *it's scary; tension, anxiety; and it requires effort to understand others*. The dominant difficulties are basic (i.e., connected with *intolerance, touchiness, or irritation of the teenager*) and instrumental (related to *inexpressive speech and inability to keep the conversation going*). Such teenagers find it difficult to communicate with those who are *cleverer and study better, do not look into your eyes, laugh often, withhold something*. They want to learn to *speak correctly and calmly, understand others, or not to be so sensitive*.

### *Communication difficulties in teenagers with speech impairments*

Teenagers with *speech impairments* were unwilling to be *proactive* in communication ( $H = 6.8$ ;  $p = 0.03$ ) and were often shy and timid. They were prone to submit to adults or those peers who are more successful in communication or to demonstrate conformity. They disliked taking *responsibility* ( $H = 11.37$ ;  $p = 0.003$ ), avoided situations that involved making decisions or supporting points of view. This behavior may have been related to *difficulties of persuasion* ( $H = 11.59$ ;  $p = 0.003$ ). Such teenagers avoid predictably "difficult" interactions and tend to replace speech with non-verbal means of communication or "meaningful" silence. They are unconfident, gullible, and disinclined to *correct their communication errors* ( $H = 12.29$ ;  $p = 0.002$ ) because they are certain that they will fail.

This group demonstrated the most negative perception of communication by teenagers. They described it as *horror! like hell, and a pointless thing, as nobody understands anything*. Many teenagers spoke of psychosomatic manifestations: *a headache starts, the stomach rumbles, there is some hammering at my temples*. The teenagers understand that the problem lies in themselves (*I speak badly; I am difficult to understand*). However, they prefer to communicate not with adults whose



speech is correct and clear, but with children who have similar speech impairments (*it's easier to talk to them; nobody laughs, and they are the same*). Such teenagers would like to eliminate *jealousy of others, stammering*; they want *not to spit when talking, replace their ugly mouth, learn not to feel shy, to make friends, to be able to start the conversation*.

### *Communication difficulties in teenagers with motor impairments*

Children with *motor impairments* were less responsive ( $H = 8.02$ ;  $p = 0.02$ ) and ready to cooperate ( $H = 12.76$ ;  $p = 0.001$ ). They found it hard to respond quickly to interlocutors' requests or remarks and were easily hurt by criticism, unwilling to make concessions and coordinate behavioral strategies (being used to assistance in moving, they often expected concessions and assistance in communication). Problems of *self-control in communication* were typical ( $H = 12.29$ ;  $p = 0.002$ ). Greater psychological exhaustion and easy fatigability prevented children from concentrating on communication or *analyzing their own communicative behavior* ( $H = 16.66$ ;  $p = 0.001$ ). Their limited social circle and restricted independence prevented the accumulation of communication experience and the exploration of new, more effective role strategies in interaction. Such teenagers are easily excited, oversensitive to environmental irritants and moody — all of which result in emotional expansiveness, *aggression and unwillingness to make concessions* ( $H = 13.26$ ;  $p = 0.002$ ).

Children with motor impairments are quite pragmatic as far as communication is concerned. They consider it to be *an opportunity to demand that which belongs to them, ask for help, or a way to solve a problem*, sometimes as an instrument of manipulation (*it's possible to use others for your own purposes, to cause pity*). They have difficulties in communication when they fail to *attract attention to themselves, find a defender, or act according to the situation*. Difficulties related to self-control occur more often (*I can't pull myself together, can't keep silent, or can't refrain from being harsh*). Such teenagers are reluctant to admit and rectify their own mistakes (*let others fit in*). They do not want to communicate with *healthy children, with leaders, with top students, or with smart guys*; they often say *it's unfair! Why do others have everything and I have nothing?* They want to learn to *be the heart and soul of the group, to crack jokes, be cool, and not to be shy*. The most violent teenagers want to *feel nothing, learn to avenge, be able to hurt the offender*.

### *Communication difficulties in typically developing teenagers*

The research revealed that typically developing teenagers are more likely to experience problems in their choice of *verbal and non-verbal means of communication* ( $H = 26.467$ ;  $p = 0.003$ ) and in *communication planning* ( $H = 22.163$ ;  $p = 0.002$ ). Compared to physically impaired teenagers, typically developing ones mostly had *basic communication difficulties*, related to a decrease in *rapport* ( $H = 7.4$ ;  $p = 0.03$ ) and *empathy* ( $H = 11.12$ ;  $p = 0.003$ ) or to *emerging aggressive interaction forms* ( $H = 12.29$ ;  $p = 0.002$ ).

It is worth mentioning that both physically impaired children and their typically developing peers experience *similar communication difficulties* — aggression, intolerance, the inability to admit wrongdoing or make concessions, difficulties with empathy, self-control, self-analysis and self-expression in communication. The

same difficulties were revealed to be present in the representative sample ( $n = 540$ ), which enables the authors to argue that these communication difficulties are typical of the age group in general, determined by the laws of continual genetic developmental (Sergienko, 2012) and can be overcome by solving typical key age-related problems of communication.

### *Subjective emotional experiences of teenagers in impaired communicative situations*

The content analysis of the sentence completion test showed that physically impaired teenagers demonstrate higher degrees ( $p \leq 0.002$ ) of emotional experience related to an impaired communicative situation. In comparison to the respondents from control groups, physically impaired teenagers are more often inclined to perceive interaction as a stressful process fraught with problems that requires effort to overcome. Such teenagers are anxious when they find themselves interacting in an unfamiliar situation with people whom they hardly know or understand; they are excited, shy and afraid to express their opinion. They think up of feeble excuses and discriminate against interlocutors. The subjective reasons for impaired communication, according to physically impaired teenagers, lie either in their own emotional expansiveness, aggression, and irritability or their shyness, inner barriers, proneness to conformity, and infirmity. Physically impaired teenagers felt uncomfortable while interacting with an aggressive interlocutor: visually impaired children were oversensitive to criticism ( $\varphi^* = 2.252$ ;  $p = 0.001$ ), teens with auditory impairments disliked it when interlocutors were reticent about something ( $\varphi^* = 4.677$ ;  $p = 0.000$ ), children with motor impairments were afraid of being physically abused ( $\varphi^* = 2.235$ ;  $p = 0.007$ ), and teenagers with speech impairments could not tolerate verbal aggression from interlocutors ( $\varphi^* = 1.992$ ;  $p = 0.02$ ). Most physically impaired teenagers believed that they could cope with their own communication difficulties if only they were “like everybody else”, i.e., the realization of the disability negatively affects self-identity and communicative self-presentation. At the same time, visually impaired teenagers dreamt of becoming brave, fearless, easy-going, and proactive ( $\varphi^* = 5.354$ ;  $p = 0.000$ ). Teenagers with auditory impairments dreamt of learning to speak correctly, beautifully and expressively ( $\varphi^* = 5.103$ ;  $p = 0.000$ ). Children with speech impairments wanted to be more persuasive and eliminate the fear of being misunderstood by interlocutors ( $\varphi^* = 1.986$ ;  $p = 0.01$ ). Teenagers with motor impairments wanted to be able to talk to unfamiliar people easily and be liked by them ( $\varphi^* = 1.765$ ;  $p = 0.04$ ). Therefore, physically impaired teenagers most evidently realize verbal communication difficulties, difficulties with effective cooperation and mutual understanding, and self-expression in interaction. The motivation for self-perfection in interactions is also obvious.

In impaired communication situations, teenagers from the control groups experienced negative emotions less often, were more likely to choose alienation strategies and escapism, saw the causes of difficulties in other people and circumstances, limited contacts with a “difficult” interlocutor, were unwilling to change their opinions, and did not want to obtain any new communication features. Therefore, the degree to which they realized their own communication difficulties is lower in such children than in those whose difficulties are determined by health impair-

ments. The children of the control group demonstrate no readiness to overcome emerging difficulties and their motivation for communicative self-perfection is extremely weak.

## Discussion

In interactions, *physically impaired children* often became *agents of impaired communication* and experienced negative emotions related to the understanding of their impairment, inner barriers, and shyness. More often, such children created communication difficulties for interlocutors by demonstrating excessively high expectations, aggression, hostility, jealousy, unwillingness to accept and correct wrongdoing, the inability to defend their point of view in an effective way, and a lack of readiness to cooperate and reach an agreement with interlocutors. These tendencies were especially clearly manifested in the interactions of physically impaired teenagers with their healthy peers.

Impaired communication in children with various impairments (visual, auditory, speech and motor) is characterized by *specific features* related to the nature of the impairment, the psychophysiological condition of the teenager and accumulated communication experience. Along with those, there are also *communication difficulties that are typical for all physically impaired teenagers*:

- Physically impaired children often demonstrate “*comprehension barriers*” in communication, i.e., children fail to understand requirements set by adults or wishes of their peers, understand certain facts in a different way, fail to accept interlocutors’ offers because they are interpreted in a specific way (often regarded as ridicule or fault-finding), feel that requirements are impossible to meet due to physical limitations, or perceive interlocutors in a negative way.
- Communicative situations often cause *shame of oneself and awkwardness*; physically impaired children are often anxious, afraid of entering contact, unable to plan and control themselves in an interaction, shy, or alienated. They usually expect to receive a negative attitude, ridicule, or verbal aggression, which is why they take a defensive position; they are ready to protect themselves, always on the alert, suspicious, and oversensitive to criticism.
- Some children demonstrate despotism in communication, capriciousness, or a desire to usurp adults’ attention. They expect adults to feel sorry for them, dote on them and make concessions, and make their wishes come true. Such children often emphasize their impairment to cause pity or manipulate interlocutors. In interactions, they demonstrate egotism, ostentation, petulance or high temper.

The research findings show that physically impaired teenagers find themselves under a “*triple pressure load*”. First, children are oversensitive to their own physical impairment, feeling that they are “different” or “unlike others”. Second, they experience communication problems typical of their age group and related to the need for autonomy and independence in communication. Third, they have individual specific difficulties related to the nature of the impairment, conditions of life and daily activities, and features of social networks. All these factors add to frustra-

tion, despair and a feeling of inability to change the situation. Can teenagers aged 12-13 cope with these difficulties on their own without harming their physical and mental health? The answer is obvious — they cannot. That is why it is essential to draw the attention of the professional psychological community to communication problems in physically impaired children. It is necessary to study specific communication difficulties in such children, identify them in proper time, and design programs of personalized assistance. Such programs should take into account the nature and degree of both the impairment and the communication difficulties in children with various impairments. It should also provide psychological and counseling services to such children and their families, which would make interpersonal communication optimal.

## Conclusion

The research verifies the hypothesis: in interpersonal communication, physically impaired teenagers, along with communication difficulties typical of their age, experience specific communication difficulties that differ from those of their typically developing peers. The emerging difficulties are certain to limit teenagers' interactions and their self-fulfillment and self-actualization in interpersonal relationships. Experts in clinical, specialized and social psychology should join their efforts to develop communicative skills in physically impaired children within the framework of the existing remedial and developmental programs. It is clear that such programs should be differentiated not only according to the nature of the impairment but also according to the type of communication difficulties that prevent the constructive development of the speaker.

The commonly asked question refers to the plausibility of teaching physically impaired children in closed schools for special education. We find it impossible to give a straight answer to this question. Specialists from other countries also leave the discussion open. On the one hand, the findings of the research show that the deprivational social environment prevents teenagers from adapting to the surrounding world successfully. It adds to the risk of developing more communication difficulties in physically impaired children. Therefore, the solution lies in mass inclusive education. On the other hand, communication difficulties result from the degree and nature of the impairment, conditions of the child's early age socialization, and not only specific communication in a closed social group. For example, a child with heavy visual, auditory or speech impairments who was pre-schooled at home will have significant difficulties studying in an inclusive educational institution. It will aggravate communication difficulties due to the child's inability to study the material successfully as well as gelotophobia, bullying by peers, social isolation, and so on.

We believe that there are no standard methods. An individual approach to each physically impaired child will reveal the child's communication potential and overcome current problems in communicating with peers and adults. The methods may vary: inclusion, special education, remedial teaching groups, meetings with typically developing children, extracurricular education common for all types of children, and others. The main aim remains unchanged: it is the psychological and counseling support of the ontogenesis and dysontogenesis of the communication agent.

## Limitations

Undoubtedly, the universal nature of the obtained data is limited by the paucity of the sample, the need to focus on the nature of individual communicative difficulties in teenagers, and the specifics and degrees of their impairments. The identified features cannot be regarded as regular; the research only registers the fact of tendencies in impaired communication among physically impaired children.

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## Psychological predictors of inhibition development in educational environments

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This article examines psychological predictors of inhibition in educational environments as well as various aspects of pedagogical communication, including facilitation, which is aimed at enhancing educational effectiveness and developing students by means of using a particular communication style and the teacher's personality. The need to study inhibition (the deterioration of teacher-children interactions; the negation of a student's individuality; the inability to understand and accept students' viewpoints; teacher-provoked conflicts; and emotional callousness) is substantiated. The essence of psychological predictors as independent variables, changes in which lead to changes in other dependent variables, allowing the prediction of inhibition development, is explained.

The research objective was to identify psychological predictors of the development of inhibition in pedagogical communication.

An empirical study was conducted using standardized techniques for diagnosing communicative attitudes (V. Boyko), developing general communicative tolerance (V. Boyko), identifying aggressiveness (A. Asinger), identifying the level of empathy (V. Boyko), and identifying the degree of pedagogical inhibition (L. Polosova). The sample contained 375 teachers from Yekaterinburg educational institutions, with participant selection made using stratified sampling.

The teacher's personality features (a negative communicative attitude, low communicative tolerance and empathy, and higher levels of aggression) were shown to be key predictors of inhibition, which itself was found to depend on the length of teaching experience. At the beginning of one's professional teaching career, the level of inhibition is minimal. However, the level of inhibition reaches its maximum level after 5-10 years of teaching, and after 20 years, there is a sharp decrease in the level of inhibition.

The conclusion of this study stresses the importance of developing strategies to prevent and correct inhibition, which is especially essential for school teachers with 5-10 years of experience.

**Keywords:** pedagogical communication, inhibition, facilitation, educational environment, psychological predictors of development

## Introduction

The modern historical period of development, with its intensity, dynamism, contradictory trends and alternative viewpoints, differs sharply from previous periods, which are characterized by predictability and regularity, not in the quality or standard of living, but in its essence. Today, the availability of new cognitive technologies forms the basis for society's technological structure of an entirely different form and substance compared to all previous attempts (Sundiev, 2012).

This new technological structure is not associated with the production or processing of materials, but rather with changes in human beings. There now appear to be ways to transform personality, giving it desired properties and qualities. These methods are becoming increasingly effective, allowing the prospect of interfering with the production of human consciousness. According to I.A. Prokhorov, human consciousness will become as productive a force as science once was (Prokhorov, 2015).

In this context, the main objective of psychological science shifts from the simple diagnostics of different personality types to forecasting an individual's personality features and actions. Studying human potentialities, diagnosing the moral foundations for individual behavior in an accurate and timely fashion, and predicting success in activities and abilities to solve a wide range of non-standard tasks can be defined as some of the most important psychological objectives for the near future.

Consistent with this notion, changes in the Russian education system call for an entirely new professional organization; that is, they can be effective only within a new professionalizing socio-cultural paradigm. Its main distinctive feature is the change in the subject-subject relationship. There is a shift from meeting the need for highly qualified staff to supplying society with personnel trained by the new educational system, itself aimed at developing a creative mentality, professionalism and a person's moral maturity.

Under these circumstances, special attention should be paid to how pedagogical communication is organized.

## *Theoretical framework*

At the core of pedagogical communication is the teacher's personality. Indeed, personality has a major impact on all aspects of communication, including perceptive, communicative, and interactive facets. The whole range of a teacher's personality features and communicative potential is uncovered in real interpersonal contacts (Rean, 1999).

Societal demand for highly professional educators who can create a favorable psychological atmosphere in the educational process and thus a foundation for children's emotional well-being forced scientists to take a fresh look at the issues of teachers' professional development (E.M. Bobrov, S.V. Vasilkovskaya, V.P. Savrasov and others) and professionally relevant features of a teacher's personality (F.N. Gonobolin, E.A. Grishin, Ya.L. Kolominsky, N.V. Kuzmina, A.A. Rean, and others).

In his works, A.A. Leontiev concluded that pedagogical communication takes place at all stages of one's upbringing and education. It first develops in infancy and

early childhood, becoming more complex in its content and form in primary and secondary school lessons as well as in other types of educational work with students (A.A. Leontiev, 1996).

A.B. Orlov found that organized, pedagogically appropriate communication affects many aspects of students' personalities. These include their character, interests and abilities, in addition to their mental and moral development and personalities' emotional characteristics. The cognitive function of communication is also exemplified through the course of communication with students: teachers learn a lot about students and learn to analyze their psychological make-up (Orlov, 1983).

I.A. Zimnyaya believed that the effectiveness of pedagogical communication is inextricably linked with the teacher's personality and, as such, is determined by a range of factors. These factors include the teacher's personality features, which are important for communication; his or her communicative abilities and skills; the nature and style of pedagogical communication; and the effect of the nature of pedagogical communication on students' mental development. This author also highlighted such personality features as communicative attitudes, abilities, skills and knowledge, tolerance and empathy as being important for communication (Zimnyaya, 2000).

In her research, M.I. Lisina showed that everyday communication with children creates favorable opportunities to study them from a psycho-pedagogical viewpoint. It is crucial for teachers to understand the orientation of their teaching activities and specific methodologies. Systematic observation methods are considered to be the most effective and most accessible in pedagogical practice. When interacting and communicating with other people, a person meets a special need to contact another human. One of the effective ways to identify the nature of the need for communication is by analyzing the outcomes of this activity. The primary effect of communication is its ability to shape the other person's image and the subject's self-perception (Lisina, 1979).

In several studies from the 1960s and 1970s, the issue of mutual understanding between people came to be considered in psycho-pedagogical terms (A.A. Bodalev, G.F. Guseva, S.V. Kondratieva, V.N. Kunitsyna, A.A. Rusalina, and M.P. Tihonova et al.), whereas previously it was mainly viewed as an object of general and socio-psychology (V.M. Bekhterev, A.P. Nechaev and I.A. Sikorski).

The results of these scientists' research show that a teacher must possess a whole set of qualities, the absence of which makes the implementation of a constructive relationship with a child under the conditions of pedagogical communication virtually impossible.

One of the general psychological preconditions for pedagogical communication is development of the teachers' optimum sociability, including its moral, psychological and pedagogical aspects. This will prevent any deviations, especially cold rationality, moralizing and formalism, in dealing with students, which weaken the pedagogical effect of communication and complicate the student-teacher relationship.

Pedagogical communication is the main way to implement the educational process. Its effectiveness is determined, above all, by the goals and values of communication, which should be accepted by all subjects of pedagogical communication. Such components as mutual recognition and understanding, information

exchange, and interpersonal interaction are all integral parts of pedagogical communication.

Pedagogical communication leads to the appearance of various new psychological formations, both personal and interpersonal. These formations, called changes or phenomena, can be constructive (developing) or destructive (ruining). Inhibition is one of these changes inherent in pedagogical communication that has a negative effect on the subject of interactions in the educational process.

Pedagogical communication phenomena that occur in teachers' professional activity may exert various influences on children's mental development, as well as on the effectiveness of the process of discovering the students' personality. In recent years, psychology has turned to studying facilitation as a pedagogical communication phenomenon. In his concept of education, C. Rogers, who discovered this phenomenon in educational psychology, suggested using facilitation techniques. This concept shifts the emphasis from teaching to facilitating learning; towards promoting, assisting, encouraging and enhancing learners' development, giving them more freedom and responsibility (Rogers, 1994).

Rogers' followers emphasize that education should become a means of students' and teachers' personal growth. A teacher should act as a facilitator of communication - someone who encourages students' initiative and interpersonal interaction and promotes their mental development processes.

Teachers with a high level of facilitation are very critical of themselves, always try to uncover cause-and-effect relationships, work well in and for a team, establish and maintain contacts easily, perceive students as being important, are open in communication, cheerful, directed to the outside world of surrounding people and events, and have strong leadership qualities and business skills. Such teachers are sensitive to the needs and concerns of others, are generous, have a genuine interest in people, are emotionally responsive, are eager to maintain good relationships with people and are always ready to help others.

It should be noted that it is a pedagogical influence that allows students to notice the mismatch between 'I-real' and 'I-ideal', which is a necessary condition for development. Not only does pedagogical support carry out the function of protecting students from insecurity and the fear of failure in educational tasks but also helps in establishing their personal and real-world status.

With the myriad approaches to studying teachers' professionalism, psychological facts that impair interactions between teachers and children in the course of pedagogical communication remain insufficiently researched. One of these facts, in our opinion, is the inhibition phenomenon.

Inhibition is a complex integrative formation, the development of which is conditioned by teachers' negative individual psychological attributes; it is accompanied by the deterioration of pedagogical interactions in the course of pedagogical communication with children and negatively affects their emotional development.

In social psychology, there are few studies of inhibition, which is the opposite of the facilitation effect. Inhibition is characterized by the deterioration of interaction as well as suppression of the subjects of the communication and has an abiding negative impact on them. The phenomenon of inhibition, in our opinion, is inherent in pedagogical communication and must be studied more thoroughly.

The phenomenon of inhibition manifests itself in tight and comprehensive control: the teacher resorts to a commanding tone and makes scathing remarks. Tactless remarks about some students, and unreasoned praise of others, are part of this pedagogical interaction. Such teachers set overall goals for work, indicate ways of performing tasks, and determine who will work with whom, while at the same time ignoring students' individualities and cognitive interests. Such an approach typically reduces students' motivation for any activity, as students do not know the purpose of their work, the function of each stage or what lies ahead (Pecherkina, 2013). It should also be noted that gradual regulation of student activity and tight control over them reveal the teacher's lack of belief in the students' positive potential. In the teacher's eyes, students have a low level of responsibility and deserve the toughest possible treatment, with any initiative seen as a manifestation of undesired self-will.

Relative to education, in general, and to the student-teacher relationship, in particular, inhibition acts as a deterrent to the effectiveness of learning activities, to their speed of completion and to the quality of their outcomes.

Based on both Russian and foreign authors' studies, one can assume that excitement is the main factor influencing inhibition. If a person is excited, the presence of appraising observers (teachers) will lead to increasingly less task fulfillment.

According to research by R. Zajonc, the presence of strangers improves performance on simple and familiar tasks and impairs it on complex and new tasks. The author became interested in how to interpret results that were initially contradictory. He used the principle of experimental psychology, in which excitement always strengthens a dominant reaction. Specifically, increased arousal improves the performance of simple tasks for which the most likely response is a correct decision. In complex tasks, however, where the answer is not obvious, such arousal leads to an incorrect response. In teaching, erroneous action is the most common dominant reaction (Zajonc R., Sales S., 1966).

R. Zajonc managed to experimentally demonstrate that the presence of other people strengthens excitement. This most important idea in his newly discovered concept leads to the conclusion that the mere presence of strangers impairs learning, as arousal increases and the person is often not responding properly. Such a presence, however, facilitates the performance of well-learned tasks.

Interestingly, K. Kottrel, V. Henchi, R. Glass, N. Klinger and others have shown that the presence of observers who were unable to evaluate the examinees' activity did not improve performance. An impeding or a positive effect was only present when the observers were able to evaluate the examinees' activity. Therefore, the mere presence of strangers is not a sufficient condition for inhibition. The observers, or participants in joint actions, should be seen as people who are able to assess the activities of the subjects. The ability to provide appraisal is an important component of the presence effect because based on our previous experience, each of us associates the positive or negative results of our activities with situations of appraisal. If we do our work well, we receive a favorable evaluation and obtain a positive result; if not, the appraisal is unfavorable and the result is negative (Mitrahovitch, 2002).

Hence, inhibition in the educational process has a negative effect on its quality; it causes a decline in students' motivation for learning, as well as high levels of

anxiety and aggression. As a result, predicting the development of inhibition in the communication process is an issue of current importance.

According to Yu. V. Gromyko, prediction, at present, is closest to the established forms of scientific thinking and is virtually becoming the only doctrine by which to address the future. The external formation of an object, which moves under its own laws without changing the subject's thinking or consciousness, exists and lives inside the predictable whole, and this is the most common scientific methodology of working with the future (Gromyko, 1997).

I.V. Bestuzhev-Lada defined prediction as specialized scientific research whose subject is the prospects of phenomenon development (Bestuzhev-Lada, 1982).

When studying the role of prediction in the thinking process, A.V. Brushlinsky showed that it is the vision of the target that determines the economy, validity and accuracy of the solution; the activity's success most often depends on a person's ability to foresee their own or others' future behavior and to foresee the future development of events or situations (Brushlinsky, 1979).

According to L.A. Regush, human actions committed without trying to anticipate consequences, without taking into account the connections that may arise as a result of their intervention in biological or social processes, are, at best, useless and are also frequently harmful (Regush, 2003).

Various social institutions are interested in accurate diagnoses of individuals' make-up and abilities and in reliable forecasts about the effectiveness of their future activities and behavior. To achieve these objectives, predictive technologies should be used to identify and develop effective human resources. Predictors are a tool for obtaining these forecasts and a means for their expression.

The term 'predictor' (predict; to forecast) can have two different meanings, as well as both a broad and narrow context. Within its broad meaning, it is the individual's and his/her environment's initial attributes that allow the prediction of the same individual's other (desired) attributes. In its narrower meaning, the term 'predictor' acquires additional limitations that may be associated with the quantitative expression and evaluation of the forecast's statistical reliability. In regression analysis, used as a method of constructing a forecast, the term 'predictors' describes independent variables, changes in which can then lead to changes in other dependent variables (responses).

According to the nature of the effects being predicted, four basic types of predictors are distinguished: inter-level (in the personality structure), ontogenetic, professional and clinical.

Attributes or independent variables used for constructing predictors may be obtained from two main sources. The first source is a person's own characteristics. These can include a wide range of psychological and physiological qualities, from somatotype to communication style. The second source concerns the environmental factors of a person's existence: physical (space and objects) and social (family and wider circles of social interaction). The predictors' self-descriptiveness becomes higher when they combine the action of at least two or more factors (independent variables), that is, they have a complex nature.

The procedure for constructing complex predictors is used to identify individual predictive attributes and integrate them into complex predictors of psychological properties by means of multidimensional statistical analysis. In the course of



statistical processing, both a person's attributes and environment, components that are potentially "significant" to the formation of the target attribute, can be included in the complex predictor.

Thus, the study of psychological predictors entails identification of the range of factors that determine the development of a psychological phenomenon and, additionally, an evaluation of these factors' influence on the effects being predicted (Maryutina, Trubnikov & Ermolaev, 1998).

As a result, it becomes relevant to identify psychological predictors of inhibition development in pedagogical communication.

Based on a theoretical analysis of the body of literature (V.V. Boyko, I.A. Zimnyaya, E.F. Zeer, N.V. Kuzmina, A.K. Markova, L.M. Mitina, C. Rogers, C. Maslach, S. Jackson), we singled out the following psychological predictors of inhibition in the educational environment: communicative attitude, communicative tolerance, empathy and aggression. We then conducted an empirical study to identify the content of each predictor.

## **Method**

The purpose of this research was to identify psychological predictors of inhibition development in pedagogical communication.

The research objective is to determine the factors that have a negative effect on children's emotional development in the course of pedagogical communication.

The theoretical and methodological basis for the research draws on the following:

- Theories of personality-oriented professional education (D.A. Belukhin, E.F. Zeer, I.A. Zimnya, A.A. Rean, L.A. Regush, V.V. Serikov, M.N. Snatkin, and I.S. Yakimanskaya);
- Personality-based and activity-based approaches (A.G. Asmolov, A.N. Leontiev, S.L. Rubinstein, and A.V. Petrovsky);
- Concepts of pedagogical activity and a teacher's personality (F.N. Gonobolin, V.A. Krutetsky, N.V. Kuzmina, A.K. Markova, and V.A. Slastenin);
- Research into the influence of a teacher's professional activity on personality deformation development (S.P. Beznosov, V.V. Boyko, M.V. Borisova, N.E. Vodopyanova, N.V. Grishina, S. Jackson, E.F. Zeer, K. Maslach, L.M. Mitina, V.E. Orel, E.I. Rogov, T.I. Roginskaya, E.S. Starchenkova, and E.E. Symanyuk);
- Study of the issues of effective pedagogical communication (L.N. Bashlakova, I.A. Zimnyaya, Ya.L. Kolominsky, S.V. Kondrateva, E.A. Panko, L.M. Putyato, C. Rogers, and S.S. Harin),
- Theory of communication and activity unity (G.M. Andreeva, A.N. Leonatiev, B.F. Lomov, and D.B. Elkonin).

## **Hypothesis**

The teacher's individual psychological characteristics, such as negative communicative attitude, low level of communicative tolerance, low empathy and high aggression level, serve as internal predictors of inhibition development in teachers.

**Research methods**

- The technique for diagnosing teachers' communicative attitudes (V.V. Boyko) identified the indicators of a negative communicative attitude, namely, implicit violence, open violence, justified negativism, grumbling, and negative communicative experience.
- Assessing the level of teachers' general communicative tolerance (V.V. Boyko) included examining the following domains: rejection or misunderstanding another person's individuality; using oneself as a reference when evaluating other people's behavior and way of thinking; self-righteousness or conservatism in evaluating other people; inability to hide or smooth unpleasant feelings when dealing with uncommunicative partners; desire to change partners; desire to adjust partners to oneself and make them "convenient"; inability to forgive others' mistakes, awkwardness, confusion, or unintended trouble caused to partners; intolerance to physical or mental discomfort caused by other people; and inability to adapt to other people's characteristics, habits and desires.
- The technique for assessing the level of aggression (A. Assinger) comprised a single scale to identify the degree of aggressiveness manifestation — that is, moderate, excessive or medium.
- The technique for assessing the capacity for empathy (V.V. Boyko) included the following scales: rational channel of empathy, emotional channel of empathy, intuitive channel of empathy, attitudes encouraging empathy, penetrating power in empathy, identification in empathy, and one's general level of empathy;
- The questionnaire used to assess the degree of pedagogical inhibition (L.B. Polosova) comprised a single scale to identify the extent to which manifestation was being inhibited — that is, low, medium or high.

**Research stages**

The study of psychological predictors of inhibition in the course of interactions between teachers and children in pedagogical communication was conducted from 2010 to 2014 and included three stages.

The first stage (2010) was devoted to psychological and pedagogical literature analysis. The scientific concept of inhibition was defined and its constituent parts determined. We then formed the conceptual framework for the research.

During the second stage (2011), the research subject – psychological predictors of inhibition — was determined. Psychodiagnostic methodologies were then developed, selected and adapted.

The third stage (2012–2014) was devoted to studying psychological predictors of teachers' inhibition and to analyzing and summarizing the research results.

To determine the differences in the manifestation of individual psychological characteristics in teachers with varying levels of inhibition, a comparative analysis using the Mann-Whitney U test was carried out.

The study was conducted individually and anonymously. Each teacher received a packet of forms with questionnaires.

## **Results and discussion**

Our sample contained 375 teachers of different subjects from various secondary educational institutions in Yekaterinburg, with participant selection made using stratified sampling. Eight schools from different administrative districts of Yekaterinburg were randomly selected, and all of the teachers within each school, without exception, were subsequently examined. Since the vast majority of the teachers were women, the conclusions obtained may not be generalizable to males.

The age distribution of the sample was as follows: 20% were under 30 years, 30% were aged 30 to 40, 38% were 40 to 50 years old, and 12% were over 50.

The distribution of the participants according to their teaching experience was as follows: up to 3 years — 12%; 3 to 5 years — 37%; 5 to 10 years — 25%; 10 to 20 years — 21%; and 20 to 30 years — 5%.

Each participant had earned a degree in pedagogy, with 78% holding a university degree and 12% a vocational training degree.

Additionally, 33.9% of the teachers were found to have a markedly negative communicative attitude. Teachers with a negative communicative attitude had high scores on two related domains: covert severity (62.5% of teachers) and reasonable negativity (47.5% of teachers). Overt severity was observed in 25.4% of the teachers, grumbling in 25%, and negative experience of communication in 16%.

Teachers with a markedly negative communicative attitude are disposed to hostility, wary of dealing with people, prone to make negative conclusions about people and reluctant to respond to others' concerns. Moreover, they have an inflated self-esteem and reduced self-criticism. They can be aggressive and inconsistent in their statements, although they tend not to identify these qualities in themselves. As a rule, they prefer not to hide and not to soften their negative estimations and experiences. These characteristics can erode the pedagogical communication process and create a negative emotional background and thus threaten the nurturing atmosphere of the educational environment.

Questionnaires also showed that 30.5% of the participants had low levels of communicative tolerance.

Teachers with low communicative tolerance scored highly in the following areas: rejection and lack of understanding of a person's identity, 37.5% of participants; categorical/unqualified and conservative judgements about people, 40%; inability to hide unpleasant emotions when encountering uncommunicative partners, 50%; tendency to demand flexibility in their partners in terms of personal relationships, 37.5%; and an inability to adapt to one's partner. 37.5%.

Such components as using oneself as a benchmark for evaluating others were found in 25% of the teachers; a desire to change and re-educate the partner in 20%; a lack of ability to forgive mistakes or gaffes in 20%; and an unwillingness to tolerate physical or mental discomfort from the partner in 20%.

A low level of communicative tolerance determines behavior and causes lasting maladjustment to the communication partner. Teachers with low levels of communicative tolerance are unable to accept students' identity in pedagogical communication due to a mismatch of personality substructures, thus denying the students the right to individuality. They also judge children relative to their own habits, at-

titudes and moods and may show unmanageable negative reactions in response to antisocial qualities in children. Such teachers try to re-educate students in a rough or a soft manner, seeking to regulate their actions and make children behave like they themselves. These teachers insist that children adopt their viewpoints, evaluate students relative to their own circumstances, and so on. In cases where a child is looking for sympathy, the teacher does not notice, gets irritated or condemns them.

High levels of aggression were found in 62% of the teachers. This suggests that they are prone to outbreaks of aggression, which are more destructive than constructive. They are also prone to ill-considered actions and fierce debates, may treat people disparagingly, and by their own behavior, provoke situations of conflict that could be avoided. In other words, it can be assumed that a high level of aggression has a damaging effect on students' personality structures.

One's level of empathy characterizes the person's focus of attention, perception and thinking on understanding another person's nature, condition, problems and behavior. As such, 67% of the teachers were found to have low levels of empathy. This characteristic manifests itself in the inability to understand another person's inner world and predict the interlocutor's behavior; in an avoidance of personal contacts; and in the development of a limited range of emotional responsiveness and empathic perception.

The next stage of this research was identifying the degree of inhibition in teachers using the questionnaire developed by Polosova L.B.

The majority of the teachers were found to have medium and high levels of inhibition.

Between-group comparisons of communicative attitude indicators showed that the compared groups exhibited statistically significant differences in the degree of a number of variables, specifically, covert severity ( $z = 164.10$ ;  $p = 0.04$ ), overt severity ( $z = 171.0$ ;  $p = 0.04$ ), reasonable negativity ( $z = 157.50$ ;  $p = 0.02$ ), and negative experience of communication ( $z = 116.5$ ;  $p = 0.04$ ).

Teachers with high levels of inhibition (42%) also had higher levels of covert and overt severity towards others, demonstrated reasonable negativity in judgements about people, and received high scores on measures that confirmed a negative personal experience in communicating with others. Their judgements contain, in a disguised, subdued or sometimes overt manner, hostility, wariness in dealing with many partners, negative conclusions about people, and an unwillingness to sympathize with other people's problems. They are also characterized by poor control over their own emotions and behavior.

The participants with low levels of inhibition (15%) demonstrated low scores in all of the components of communicative attitude.

The analysis of differences between teachers with high and low levels of inhibition revealed significant dissimilarities in the magnitude of components to communicative tolerance. Specifically, analyses showed a rejection or a lack of understanding of human individuality ( $z = 169.0$ ;  $p = 0.04$ ), rigidity or conservatism in their estimations of other people ( $z = 134.0$ ;  $p = 0.04$ ), inability to hide or sooth unpleasant feelings when encountering antisocial qualities in partners ( $z = 180$ ,  $p = 0.03$ ), desire to make their partner adapt to themselves ( $z = 100.0$ ,  $p = 0.02$ ), and

inability to adjust to their partners ( $z = 122.0$ ;  $p = 0.04$ ). Reliable differences in aggression indicators were also found ( $z = 112.5$ ;  $p = 0.02$ ).

Teachers with high levels of inhibition have low scores on empathy, high scores on aggression, a low degree of communicative tolerance, and demonstrate a marked negative communicative attitude in pedagogical communication.

Teachers with low levels of inhibition have higher scores on empathy, low scores on aggression, an adequate degree of general communicative tolerance, and show appropriate communicative attitudes in pedagogical communication.

This study also revealed a correlation between the degree of inhibition and amount of teaching experience.

The highest degrees of inhibition were observed in respondents with 5 to 10 years of experience (Table 1).

**Table 1.** Degree of inhibition in groups with different teaching experience, %

Teaching experience	up to 5 years	5 – 10 years	10 – 20 years	20 – 30 years
High level of inhibition	0	67	40	20

Teachers with no more than 5 years of teaching experience tend to search for optimum behaviors and better ways in which to perform professional activities. As a result, they demonstrate a readiness for possible failure, and the lack of professional status renders them less afraid to make mistakes, as unsuccessful professional activity is normal at this stage. Therefore, strong manifestations of inhibition in this experience-level group were not observed.

The degree of inhibition increases dramatically in teachers with 5 to 10 years of experience and was observed in 67% of the subjects. This appears to reflect a connection with the fact that this stage is characterized by gaining experience and elevating the employees' status, which can result in increased dissatisfaction with the activities performed and positions held. At this juncture, strategies for professional development and surmounting professional difficulties are not yet established; this results in the release of psychological tension in pedagogical communication at a cost to the teacher-dependent students.

The results obtained in the group with 10 to 20 years of experience show a dramatic decrease in inhibition (only 40% of the respondents showed a high degree of inhibition). This may be due to the respondents' age characteristics and to their choosing suppressive behavior strategies. People at this stage actively change their lives and are searching for more fulfilling life strategies.

The results for the group of teachers with 20 to 30 years of experience fit the overall downward trend of the degree of inhibition, again depending on the extent of teaching experience. Only 20% of those respondents showed high levels of inhibition. This may be due to the achievement of an increased professional status and its importance for teachers, as well as to the development of constructive forms of pedagogical communication and the greater ability to overcome professional difficulties and conflicts.

The results of this empirical research reveal the essence of the concept of inhibition not only as a suppressor (considered as such by R.R. Miller, M.A. Laborda,

C.W. Polack and others) but also in the context of pedagogical communication. This approach is new to the science of psychology, both foreign and Russian.

Researchers have extensively studied the effects of facilitation on educational process. E.F. Zeer is the author of the concept of facilitation in teaching (Zeer, 2010). E.G. Vrublevskaya and O.I. Dimova have studied facilitating communication as a form of pedagogical interaction (Vrublevskaya, 2001; Dimova, 2002). In addition, I.V. Zhizhina and O.N. Shakhmatova considered issues with regard to developing facilitation skills in teachers (Zhizhina, 2000; Shakhmatova, 2006).

Rogers explored the characteristics of personality, activities, communication and creativity in teachers who are capable of facilitating learning (Rogers, 1994). Tassou noted that the teacher must create an environment of psychological safety for the student, where there is no external assessment. He emphasized the fact that the teacher-facilitator contributes to the formation of learners' creativity and self-expression (Tassou, 2009).

Thus, the study of psychological predictors of inhibition in the context of pedagogical activity is new to the science of psychology and extends the idea of the teacher's role in developing teacher-learner interactions.

## Conclusion

The results obtained suggest the following conclusions:

1. The following psychological predictors are associated with increased inhibition in teachers: a negative communicative attitude, low degree of communicative tolerance, high levels of aggression, and low levels of empathy.

These qualities manifest in difficulties connecting interpersonally (with students, parents, colleagues and administrators of educational institutions) and in achieving mutual understanding with others. They also result in hostility, wariness and the inability to accept a student's individuality in pedagogical communication, as well as in attempts to re-educate them and a desire to regulate their actions. Such teachers insist that students adopt the teacher's point of view, are prone to ill-considered actions and fierce discussions, disparage students and often provoke conflicts that could be easily avoided. These teachers do not seek to understand the inner world of any other person, are unable to predict the interlocutor's behavior, avoid personal contacts, and demonstrate emotional callousness.

2. The degree of inhibition and its manifestation were found to correlate with the amount of teaching experience. At the beginning of one's professional life, the degree of inhibition is minimal. Later, it reaches its maximum in teachers with 5 to 10 years of experience. After 20 years or more of teaching experience, inhibition decreases sharply.

This degree of inhibition is conditioned by the lack of constructive forms of pedagogical communication and ways of dealing with arising conflicts, as well as by the lack of established strategies for professional development and the means of overcoming professional difficulties. As a result, teachers release their psychological tension on students who are dependent on them.

The results substantiate the need for developing technologies for preventing and correcting inhibition in teachers with 5 to 10 years of experience to create a more psychologically favorable atmosphere in educational institutions.



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## Gender and age aspects of child psychological defenses in child-mother relationships

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The high level of stress in modern society poses a need to study family factors and resources for the development of children's defense mechanisms in the current social environment. This study investigates correlations between maternal and child psychological defense mechanisms, using interviews, a structured clinical survey, projective drawing, and a projective game. Analysis of data from 240 people (120 children and 120 mothers) revealed specifics of the formation of psychological defense mechanisms among children aged 4 to 12 years in child-mother relationships. We suggest that maternal and child defense mechanisms have some isomorphic traits, but the level and quality of isomorphism changes with each age period of the child. Certain defensive mechanisms of mother and child appear with the same frequency. The child's gender influences the correlation between the mother's and child's psychological defense mechanisms. Initially, children are more likely to directly copy defense mechanisms observed from the mother's behavior. As they grow older, they use defenses that they have learned consciously. Based on empirical data, we also found a correlation between the maturity of the maternal psychological defense mechanisms and specifics of child psychological defense mechanisms. We propose that the maturity of maternal psychological defense mechanisms has the greatest meaning for child psychological defense mechanisms at the earliest stages of ontogenesis — it provides consistency between the mother's own psychological defense mechanisms and the psychological defense mechanisms that she teaches her child.

**Keywords:** psychological defense mechanisms, coping strategies, child-mother relationships, maternal teaching

### Introduction

A constructive psychological defense mechanism (PDM), which implies rare resort to such negative defenses as denial, regression, or reaction formation, is associated with a high level of personal hardiness (Filippovich, 2014). Many Russian and international scientists have studied how the family influences a developing

child's psychological defenses and coping behavior (M. Maler, M. Klein, A. Freud, J. Bowlby, D. Winnicott, I. Nikolskaia, R. Granovskaia, A. Zakharov, T. Kriukova, E. Kuftiak, E. Eidemiller, V. Yustickis, and others). A child's defensive repertoire is formed in child-parent relationships, when the child faces situations that can be identified as traumatic, ambiguous, and threatening to child's identity (Docenko, 2009; Eidemiller & Yustickis, 1999; Leontiev, 2009; Nikolskaia & Granovskaia, 2001). Both the general family situation and the parents' defensive behavior influence a child's defensive repertoire (Ainsworth, 1977; Bowlby, 1982; Eidemiller & Yustickis, 1999).

The system of psychological defenses in the context of this research is defined as an implicit scheme of reacting to basic difficulties in life, which prevents the personality from losing its identity. The effectiveness of this system is closely connected with personal hardiness and coping abilities; it provides moderate filtration and processing of traumatic information, and a constructive system defends the personal identity without losing touch with reality.

A. Freud (1936) first discovered the important role of the microsocial environment in the development of the child's psychological defenses, while she was studying their meaning for resolving external sociogenic conflicts. She examined such defense mechanisms as perceptive, intellectual, and motor automatisms of different complexity levels, which are formed in the process of volitional and involuntary learning. Traumatic events in early interpersonal relationships were hypothesized to be a key factor in the development of psychological defense mechanisms.

Russian psychologists have also studied parent-child relationships a great deal (G. Burmenskaia, M. Buianov, A. Varg, B. Garbuzov, V. Lebedinskii, E. Sokolova, V. Stolin, E. Eidemiller, V. Yustickis, and others). The structure and dynamics of coping strategies in a family and the role of physical punishment in a family were studied by E. Kuftjak (2012, 2013). The experiments of E. Sokolova (2011, 1989) revealed that parental emotional rejection and emotional symbiosis block the child's tendency for rejection or attraction, respectively. These disturbances can develop in the child a feeling of helplessness and can trigger the formation of psychological defense mechanisms. The ontogenesis of psychological defenses is a heterochronous process of formation of new adaptive forms of behavior, which have both a conscious and unconscious character (Portnova & Bogomolov, 2008).

Gender differences have been well studied at the preschool age. Nevertheless, researchers have focused mainly on general differences in children's behavior. Thus, it is well known that boys are more active, and they aggressively explore the environment; they are disposed to independence and isolation, whereas girls are more disposed to social contact and friendship (Kostikova, 2000). In addition, girls' speech development proceeds more rapidly in preschool and primary school than boys' speech (Ushakova, 2006). P. Cramer and W. College (2000) argue that defenses directed toward other people (transferring one's own conflict to environment) are more typical of men, whereas defenses implying changes in personal perception of events are more typical of women (Solovyova, 2013). Considering these gender specifics, we suggest that boys' prevailing defense mechanism is avoidance and they are disposed to isolation, whereas girls tend to seek social support more actively and use mostly verbal defense mechanisms.

With respect to age and the specifics of children's psychological defense mechanisms, Belova (2011) showed that the displacement defense mechanism is more frequently used at primary school age than at preschool age, which could be due to the child's engaging in an aggressive environment.

Nikolskaia and Granovskaia (2001) investigated gender differences in children's psychological defense mechanisms in primary school. They argued that "old" defense mechanisms, formed at preschool age, are consolidated at the age of 7–12. Boys tend to active intervention in a situation (struggling, fighting, verbal abuse) twice as often as girls, emotional discharge, and are disposed to withdrawal and distraction (dreaming, relaxation), whereas girls tend to seek social support (crying, hugging). Hence, boys discharge their emotions by social aggression and girls seek sympathy and understanding as a base of support in coping with difficult situations. The phenomena of children adopting the defensive and coping behavior of adults has also been well studied by many researchers (Kuftiak, 2012, 2013). Nevertheless, the specifics of psychological defenses in a mother's interactions with her son or daughter have still been insufficiently explored.

Based on existing knowledge about children's psychological defense mechanisms, we can say that their development is shaped by both environmental factors (social situation, microsocial relationships) and inherent factors (gender, specifics of intellectual and emotional development, age). As the psychology of personality is a complex system concept, psychological processes should be investigated using a systems approach. Studies of the I-conception, personality development, self-realization, and system determination have been conducted according to the system approach (Asmolov, 2007). Existing scientific models and concepts focus on different aspects of the function of psychological defense mechanisms, but do not give a clear picture of the developing child's psychological defense mechanisms in the context of child-mother relations.

## **Method**

In psychological science and clinical practice, the mother more often than the father plays the most active role in the child's upbringing and responds to the child's request for psychological support. The goal of this research is to discover specifics of interconnection between child and maternal psychological defense systems, in relation to the child's gender and age. We assume child-mother relationships to be the basis of forming the child's defenses.

We conducted the following research tasks:

1. We analyzed the correlation between maternal maturity and the child's psychological defense mechanisms.
2. We tested our hypothesis about the isomorphism of the mother's and child's psychological defense mechanisms in different age groups.
3. We searched for common characteristics among children's psychological defense mechanisms (intensity of stress perception, sociability, level of self-esteem, need for additional defenses, and anxiety level).

This study is generally based on the system approach, particularly the holistic concept of developing psychological defenses in one's personal life support system. This involves a multilevel system of psychological reactions, the main functions of which are protecting personal integrity, providing optimum adaptation to life circumstances, and discovering the necessary resources for personal development (Belova, 2011). Scientific knowledge about psychological defenses can be systematized based on the concept of a personal life-support system, taking into consideration all significant factors of their formation (age and gender, threats to the child's identity, resources, and maturity of the maternal psychological defense mechanisms). This methodological approach allows us to investigate interactions of maternal and child defensive systems in diverse aspects and to draw prognostic conclusions.

In our research, maternal "teaching of psychological defense mechanisms" refers to the purposeful transfer of skills and knowledge, that is the mother's verbal instructions, advice, explanations to the child about how to react to stress, or non-verbal encouragement and direction of the child's defensive behavior in the way she considers best for the child.

The maturity of a psychological defense mechanisms is an integral concept, implying a wide range and great flexibility of defensive repertoire. It can be measured by the optimal "intensity of defensive behavior,"<sup>1</sup> characterized by the optimal frequency of using defense mechanisms and the prevailing usage of secondary (higher level) psychological defense mechanisms (Docenko, 2009; Nikolskaia, 2012). Mature maternal psychological defense mechanisms use mostly constructive defense mechanisms and the maternal teaching process corresponds to the mother's own defensive behavior. This has great meaning for the consistency of upbringing. A mother with mature psychological defense mechanisms is more conscious of what she is doing, and her verbal teaching is supported by experience; she uses in her own behavioral practice the psychological defense mechanisms that she teaches. Congruency and consistency between the mother's defensive behavior and her verbal teaching provide favorable conditions for the child's interiorization of the psychological defense mechanisms that his or her mother has approved.

To group the mothers in our sample according to the maturity of their psychological defense mechanism system, we used both quantitative and qualitative approaches. First, we defined three groups on the basis of data on the difference between the quantity of constructive and destructive defenses. We verified the results with the "Life Style Index" questionnaire, using expert assessment. Five experts in family psychological clinical practice and competent in issues of PDM were asked to divide the mothers into three groups of PDM maturity, based on the mothers' answers to a structured interview. Then we compared the results of the grouping by relatively qualitative and quantitative methods. The results matched completely.

<sup>1</sup> The intensity of defensive behavior was defined as the intensity of defense mechanisms in behavior. It was calculated on the basis of the "Life Style Index" questionnaire, developed by Plutchik, Kellerman, and Konte (1979), using the following formula:  $n/92 \times 100\%$ , where  $n$  is the sum of all checked answers in the questionnaire.



Methods for this study were chosen in accord with the main research purpose. They are questioning, interviewing, testing, and projective methods (drawing, game).

For gathering data about mothers, we used:

1. A structured interview, which was necessary for the psychological anamnesis and to gather information about qualitative specifics of the mother's psychological defense mechanisms and the child's defensive behavior in threat situations.
2. The "Life Style Index" questionnaire, developed by *Plutchik*, *Kellerman*, and *Konte* (1979) and adapted for Russian samples by *Romanova* and *Gribenikov* (1996) and by *Vasserman*, *Eryshev*, and *Klubova* (2005). The method identifies eight basic defensive mechanisms (denial, repression, displacement, compensation, reaction formation, projection, intellectualization, and regression) and helps to identify prevailing primary or secondary personal defenses. This instrument is introduced in a convenient standardized form and has high diagnostic capability for this research.

For gathering data about children, we used:

1. The method of serial drawings and stories developed by *Nikolskaia* (2010). It has sufficient diagnostic value in work with children because of its consistent conversations based on drawings. The conversations proceed as a sequence: making contact, identifying a stressful situation, and coping with stress, including bringing to bear the child's inner resources. Stories suggested for drawings have such topics as "I am", "When I'm sad", "It is hard for me", "Something I do not want to remember", "I'm so glad, I'm so happy" (*Nikolskaia*, 2010).
2. A projective game called "Finish the Story", which allows projection of the child's emotional statements, coping techniques, and psychological defenses in a maximally natural way, because of the comfortable and safe situation of a game. Our choice of this method was based on the assumption that games are the main and most natural activity of a child (*Elkonin*, 1999; *Vygotsky*, 1982).
3. A projective drawing method called "Person under the Rain", which provides information about the strength of the child's Ego development, stress-resistance, and coping with stressful situations. This method is used to diagnose personal reserves and to identify the specifics of defense mechanisms.

We used data about types and frequency of defenses expressed by children in correlation analysis to investigate relationships between the mother's and child's psychological defense mechanisms. The "Person under the Rain" method of projective drawing was used for verification of data about the child's PDM gathered by mean of the first two methods.

*Sample characteristics.* In total 240 people were tested, including 120 mothers and 120 children (64 girls and 56 boys). There were 57 children aged 4 to 6 years, 31 children aged 7 to 9 years, and 32 children aged 10 to 12 years.

Data analysis was carried out in the following sequence:

1. Examination of correlations between maturity level of maternal psychological defense mechanisms and specifics of the children's psychological defense mechanisms:
  - a) Classification of mothers in groups by maturity level of psychological defense mechanisms on the basis of the "Life Style Index" questionnaire and verified by experts;
  - b) Verification of the classification of the groups by discriminant analysis;
  - c) Examination of correlations between maturity level of maternal psychological defense mechanisms and specifics of interpersonal behavioral defenses *using the Spearman coefficient test* p-values.
2. Investigation of isomorphism of maternal and child psychological defense mechanisms;
3. Investigation of common characteristics among children's psychological defense mechanisms (intensity of stress perception, sociability, level of self-esteem, need for additional defenses and anxiety level).

*Methods of data analysis: content analysis, Kruskal–Wallis test, Spearman coefficient test* p-values, *discriminant analysis*, frequency analysis. *For processing data, we used the professional software SPSS Statistics 19.0.*

## Results

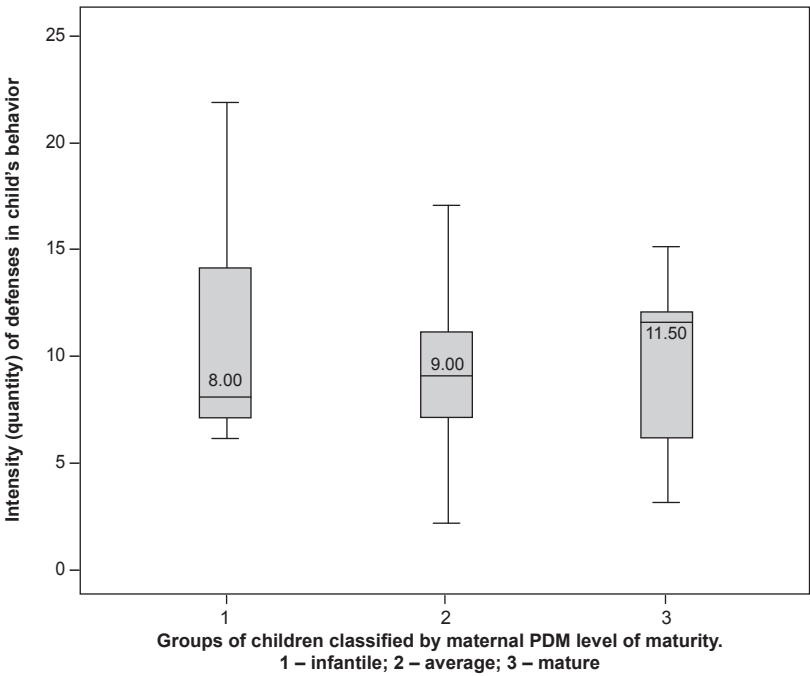
Expert analysis yielded three groups of mothers, verified by discriminant analysis:

1. 23 mothers with low maturity of psychological defense mechanisms;
2. 66 mothers with average maturity of psychological defense mechanisms;
3. 31 mothers with high maturity of psychological defense mechanisms.

In the group of children aged 4 to 6, we found differences in the intensity of defensive behavior and discovered that this intensity correlates with the maturity of the maternal psychological defense mechanisms ( $p = 0.023$ ). Using psychological defenses as the reaction to an insignificant stimulus indicates the enhanced intensity of the defense system. The higher the maturity of maternal psychological defense mechanisms, the more psychological defenses appear in the child's behavior. Intensive use of psychological defenses in childhood has a constructive meaning, because it decreases the probability of psychosomatization until higher reactions are actualized (see Figure 1).

We visualized the intensity of children's psychological defense mechanisms based on quantitative data, gathered by means of projective games and drawing methods. These data were rated from 0 up to 25 cases of using psychological defense mechanisms in behavior. We found notable differences between the mean values of intensity of children's psychological defense mechanisms in different groups, classified by level of maturity of maternal psychological defense mechanisms. In the group of mothers with infantile psychological defense mechanisms, the mean value

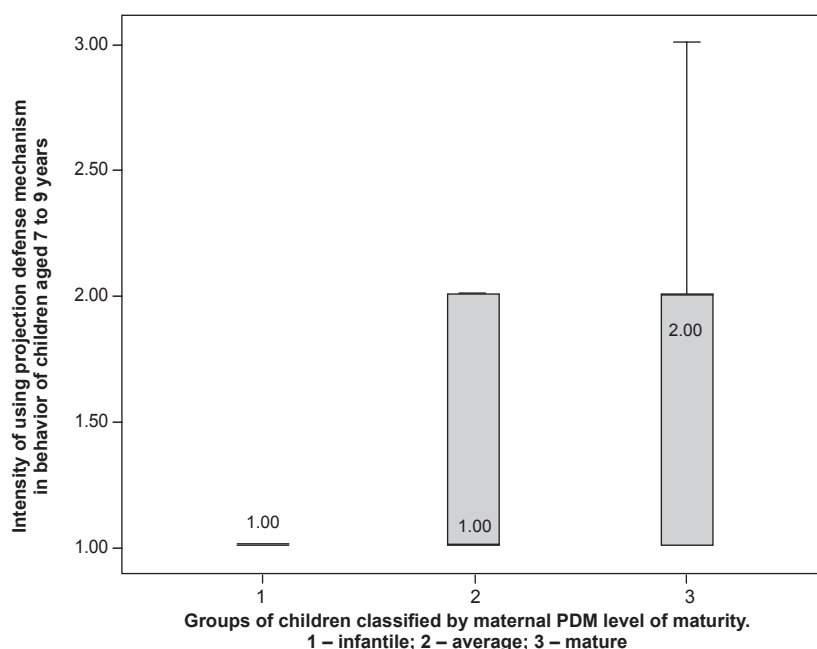
of intensity is 8; for mothers with average maturity of psychological defense mechanisms, this indicator is 9; and in the group of mothers with mature psychological defense mechanisms, it is 11.5.



**Figure. 1.** Differences in intensity of the psychological defense mechanisms among children 4–6 years old, classified in groups by the maturity of their mothers' psychological defense mechanisms.

In the group of children aged 7 to 9 years, we found differences in the frequency of using projection defense mechanism in behavior and a connection of this indicator with the maturity of maternal psychological defense mechanisms. Higher maturity of maternal psychological defense mechanisms correlates with higher frequency of the child's using projection. Children use the projection defense mechanism (see Figure 2) for better adaptation to school and to criteria for grading of students' work. They project part of their feeling of failure onto external objects and therefore enhance the stability of their identity and self-esteem. In the group of mothers with an infantile defense system, the frequency of use of "projection" in the child's behavior did not exceed once (mode 1); in the group of mothers with average maturity of psychological defense mechanisms, the frequency of use of "projection" in the child's behavior varied from once to twice, with the most frequent use being once (mode 1); in the group of mothers with mature PDMs, the frequency of use of "projection" by the children varied from 1 to 3 times, with the most frequent use being twice (mode 2).

In the group of children aged 10 to 12 years, we did not find statistically significant specifics conditioned by the maturity of maternal psychological defense mechanisms.



**Figure 2.** Differences in intensity of psychological defense mechanisms among children aged 7–9 years, classified in groups by the maturity of their mothers' psychological defense mechanisms.

We used the Spearman coefficient test  $p$ -values for studying the isomorphism of maternal and child psychological defense mechanisms. In the group of children aged 4 to 6 years, correlations between child and maternal psychological defense mechanisms are ambiguous. Mothers' behavior correlates with the frequency of using certain defense mechanisms by the child, such as "repression" ( $p=0.021$ ), "displacement" ( $p=0.001$ ), and abilities to negotiate in conflict situations ( $p=0.026$ ). If the mother teaches the child intellectualization as a reaction to difficulties, the child is more likely to use intellectualization as a desired defense mechanism in the projective game ( $p=0.048$ ). Gender specifics of isomorphism between maternal and child defense systems are described in Table 1.

We propose that a child's gender is a significant factor in the relation of maternal and child psychological defense mechanisms. In our sample, boys are disposed to copy the defense mechanism "repression" from their mother's behavior ( $p=0.04$ ), and girls tend to copy the defense mechanism "displacement" ( $p=0.015$ ).

Boys predominantly acquire skills of negotiating ( $p=0.006$ ) and emotional reaction ( $p=0.036$ ) in the process of maternal teaching, and girls use intellectualization in their behavior more successfully ( $p=0.031$ ).

Girls are disposed to perceive the defense mechanism "denial" as an approved one, as it appears in the projective game, because of learning ( $p=0.033$ ). Intensity of maternal teaching (the intensity of defenses in maternal teaching) correlates with the intensity of girls' psychological defense mechanisms. Intense efforts of the mother to teach her daughter psychological defenses increase the probability of high intensity of the girl's psychological defense mechanisms ( $p=0.042$ ).

**Table 1.** Correlations between intensity of maternal and child psychological defense mechanisms in the group of children aged 4 to 6 years, by gender

Maternal and child psychological defenses	Correlation coefficient, p-value	
	Girls	Boys
Repression in maternal and child behavior	–	0.423 0.04
Displacement in maternal and child behavior	0.418 0.015	–
Denial in maternal teaching and child learning	0.373 0.033	–
Intellectualization in maternal teaching and child behavior	0.376 0.031	–
Intensity in maternal teaching and child behavior	0.356 0.042	–
Reaction formation in maternal teaching and in child behavior	–	0.431 0.036
Negotiating skills in maternal teaching and in child behavior	–	0.547 0.006

In the group of children aged 7 to 9, we found a correlation between maternal support in training a child's psychological defenses and maternal support in the projective game. The more often the mother uses the defense mechanism of "seeking and getting support" and encourages her child to apply it, the better it is expressed in the child's behavior as a psychological defense mechanism that is desired and acquired in the learning process ( $p = 0.041$ ).

We noted gender specifics of children's psychological defenses in the age group of 7–9 years. The boys were disposed to learn their mother's defense mechanism "repression" ( $p = 0.04$ ), and the girls to learn their mother's defense mechanism "displacement" ( $p = 0.015$ ). Boys predominantly acquire skills of negotiation ( $p = 0.006$ ) and emotional reaction ( $p = 0.036$ ) in a process of maternal teaching, and girls used intellectualization more successfully ( $p = 0.031$ ). Girls were disposed to perceive the psychological mechanism "denial" as approved. Hence, the psychological defense mechanism "denial" can be identified in the projective game as a result of learning ( $p = 0.033$ ). The intensity of maternal learning (intensity of defenses) correlates with the intensity of girls' psychological defense mechanisms. Intense efforts by the mother to teach girls psychological defenses increases the probability of high intensity of girls' psychological defenses ( $p = 0.042$ ).

There is a stronger correlation in this age group between mothers' and boys' psychological defense mechanisms (Table 2). Boys have the same tendency to learn the psychological defense mechanism "repression" from their mother's behavior as in the previous period, age 4–6. Correlation between expression of the child's desired psychological defense mechanism "seeking and getting support" and the mother's effort to train and encourage her child to use this defense mechanism is approximately the same at age 7–9 ( $p = 0.02$ ).

The more the mother teaches a boy the defense mechanism "reconciliation", the more often we find it in his behavior ( $p = 0.005$ ). Boys aged 7–9 are sensitive

both to maternal psychological defenses, which were significant for them at the previous age period, and to new psychological defenses. These new psychological defense mechanisms are connected with rejection of independence and ambitions; examples are “conciliation” and “seeking support”. This situation is very important for boys’ upbringing from the standpoint of forming gender identity.

**Table 2.** Correlations between intensity of maternal and child psychological defense mechanisms in the group of children aged 7 to 9 years, by gender

Psychological defenses of mother and child	Correlation coefficient, p-value.	
	Girls	Boys
Psychological defenses of mother and child	-0.557 0.025	–
“Displacement” in mother’s behavior	–	0.551 0.033
“Seeking for and getting support” in maternal teaching and child learning	–	0.593 0.020
“Reconciliation” and “consciousness” in maternal teaching and child behavior	–	0.681 0.005

We found negative correlation between girls’ and their mothers’ emotional reactions. The more impulsive the mothers’ emotional reaction, the less girls demonstrate it in their behavior ( $p=0.025$ ). We propose that avoidance of emotional reactions in the child’s behavior is connected with low child tolerance of maternal emotions.

In the group of children aged 10 to 12, we found new positive correlations between maternal teaching and child behavior. The children were disposed to acquire the defensive skills “displacement”, “compensation”, and “tendency to reconciliation” from maternal teaching. We found a positive correlation between intellectualization in maternal and child behavior ( $p=0.034$ ) and intensity of maternal and child psychological defense mechanisms ( $p=0.009$ ).

**Table 3.** Correlations between intensity of maternal and child psychological defense mechanisms in the group of children aged 10 to 12, by gender

Psychological defenses of mother and child	Correlation coefficient, p-value	
	Girls	Boys
Displacement in maternal teaching and child behavior	0.732 0.002	–
Defensive aggression in maternal teaching and child behavior	0.650 0.009	–

Gender specifics show an absence of any significant correlation between maternal and child results in the group of boys aged 10 to 12.

In the group of girls aged 10 to 12, we found a positive correlation between “displacement” in maternal teaching and child behavior. The more the mothers taught girls “displacement”, the more often their daughters used it ( $p=0.005$ ). In addition,



we can propose that girls are capable of adopting and using defensive aggression from maternal learning ( $p=0.009$ ). This is similar across all age groups of girls in the research sample.

As for general characteristics of the child's defensive system, we found statistically significant age differences in the need for additional support ( $p=0.012$ ) and for intensity of stress perception ( $p=0.001$ )

The need for additional support tends to increase with maturation. It appears as a lack of self-confidence, decreasing self-sufficiency and psychological stability in stress situations. This situation can strengthen those psychological defense mechanisms that are inadequate to providing quality protection of the personality from threat; this requires a new personal life-support system, in particular conscious coping.

The intensity of stress perception is more evident at primary school age (see Figure 2). Increasing sensitivity of primary schoolchildren to stress appears in view of their increasing vulnerability to actual threats and their perception of stress situations as fearful and unpleasant. Perhaps this is caused by entering school, which means immersion in a new social environment with new rules and the need for adaptation to changes that encompass all areas of life.

## Discussion

### *Ontogenetic specifics of psychological defenses of children 4–6 years old*

1. The preschool age is one of the most significant for developing psychological defenses. Preschoolers have rapidly developing cognitive processes, which act as defenses. The environment gives more and more opportunities for a child to gain knowledge and self-expression. Communication in the family and in a group of peers is a context in which a child realizes age-related development tasks: taking initiative, autonomy, and adaptation of social roles.

That is why the main threat are to feelings of success, independence, and self-esteem. Psychological defenses that are forming in an interpersonal relationship with a significant adult, primarily the mother, help the child to cope with frustration. The maturity of maternal psychological defense mechanisms at this stage of development defines the child's resources for developing psychological defense mechanisms to a great extent. The mother who has relatively mature psychological defense mechanisms tends to have a maximum aspiration for excelling as a parent, because she is able to create conditions for constructive development of her child's psychological defense mechanisms. She is notable for her consistency in upbringing: Her own behavioral defenses are coherent with what she teaches her child; she is able to use higher psychological defenses and is ready to support her child in difficult situations. The defensive behavior of a mother with mature psychological defense mechanisms is flexible and variable; it is typical for her to analyze a situation, learn the lessons of a traumatic experience, and reflect upon her feelings.

In our research, we discovered a positive correlation between the maturity of maternal psychological defense mechanisms and the intensity of the child's psychological defense mechanisms. Increased intensity of the defense system is an optimal

way to adapt in childhood, which helps preserve the child's positive self-image and emotional comfort, and decreases the probability of a psychosomatic reaction to stress.

The child's psychological defense mechanisms at the age of 4–6 has traits similar to the mother's psychological defense mechanisms, first of all with her interpersonal behavioral defenses. The child successfully copies her repression, displacement, and negotiating defenses and demonstrates them in his or her behavior.

2. It is interesting that children can already learn higher-level defenses at preschool age. These may not appear in a child's behavior, but occasionally he or she practices them in games. According to Winnicott (2002), it is important acting with understanding the sense from the very early ontogenesis period. In our research, we found a positive correlation between maternal teaching of the intellectualization defense mechanism and its acceptance by the child as desirable; the child then uses it in games.
3. At 4–6 years, the child's gender has a significant influence on the defenses that the child perceives in the child-mother relationship and reproduces behaviorally. Girls have more tense connection with maternal psychological defense mechanisms than do boys. Girls tend to copy displacement from maternal behavior, whereas boys copy repression. This can be explained partially by gender specifics of upbringing: often expression of aggression is not accepted for girls, and crying or showing weakness is not accepted for boys. When the child finds an appropriate model in maternal behavior, he or she can apply it.

As for the success of maternal teaching of psychological defenses, it is easier to teach girls to deny difficulties, which they readily demonstrate in games. In the mass media, the image of the “weak”, “passive” woman (girl), who denies her ability to solve a difficult situation and looks for pleasure (chocolate, a new dress, etc.) is very common. In a game, girls often tend to neutralize problems, denying them, especially if their mothers teach them to do it.

Opportunities for conscious training in defense strategies depend on gender. Girls learn intellectualization faster and demonstrate it in their behavior. In general, the intensity of maternal teaching correlates with the intensity of girls' defense systems, not only by the mother's example but also verbally.

Boys, on the other hand, are more successful in learning emotional reactions and negotiation defenses. Teaching them how to react is a demonstration of the mother's care and consideration of her son's inner world, and he is sensitive to the training of this psychological mechanism. Reproducing negotiation skills among boys is necessary for social relationships and constructive dialogue. This is an indication of future competence.

Therefore, maternal defense resources are an important basis of forming child psychological defense mechanisms at the age of 4–6, and provides resistance to difficulties, as appropriate for this age.

### *Ontogenetic specifics of psychological defenses of children 7–9 years old*

The social situation of primary schoolchildren is quite different from that of the preschool age. The main task children face is that of switching their main acti-

vity from playing to learning. Increasing their voluntary behavior, developing self-control and self-reliance, are significant tasks of this age period.

The maturity of the maternal PDM system correlates with the frequency of projection in the child's behavior at the age of 7–9. The more mature the psychological defense mechanisms of the mother, the more frequent her child's use of projection in behavior. Although projection is one of the most primitive defense mechanisms, at this age it plays an adaptive role. At the time of entering school, the child's I-concept is especially vulnerable, because the teacher's grading of the child's work is a threat to self-esteem, and in relationships with peers, competition and the judgments of others become more important. At the age of 7–9, we find a correlation between the child's heightened intensity of stress perception and increased emotionality. At this time the child becomes especially sensitive to stress and needs the protection of a stable self-image and environment, and the need for safety must be satisfied. Projection helps the child to adapt to difficulties connected with self-esteem, preserving a positive self-image in situations of underachievement, external assessment, or loss of a leading position.

At the age of 7–9, in the process of maternal teaching, children successfully adopt a strategy of seeking and getting support and reproducing this in a game situation. Skills of getting help constructively promote a child's social effectiveness and collaborative activity. The child practices this important skill in the playing process, for its future use in difficult situations.

Gender can influence many relationships between mother and child at age 7–9, as well as specifics of the child's defense system.

We propose that maternal defensive behavior continues to set an example for boys, but they mostly copy a displacement strategy. Boys also successfully adopt from maternal teaching a strategy of seeking and getting support and an aspiration for reconciliation.

According to common cultural notions about gender, aspirations for reconciliation and seeking support are more proper for girls than for boys. Such a strategy in boys' behavior can be caused by a deficit of teaching of traditional male behavioral strategies in conflict, which are more aggressive and stubborn. At this stage, the father's participation in the child's learning and the example set by the father's behavior are important for the development of strategies that satisfy the boy's need for achievement, as well as strategies of reconciliation and intellectualization.

We conclude that girls 7–9 years old have psychological defense mechanisms that depend less on those of their mother. The maternal reaction strategy plays an important role. The more impulsiveness the mother demonstrates in her behavior, the less the girl is disposed to this strategy; she tends to demonstrate behavior opposite to the maternal example. This tendency could be caused by the child's perception of emotional reactions as unpleasant, difficult to endure. Possibly the more strongly the mother expresses her emotions, especially anger, the less the child feels able to endure this strong expression. Fear of this situation may lead the girl to difficulties in reacting and seeking psychological defense mechanisms. Furthermore, gender-specific upbringing of girls places a taboo on aggression, which may motivate the child even more than the example of her mother's impulsive behavior.

At the age of 7–9, actual threats to the child increase and this is connected with the defense of personal identity. The probability of the "projection" defense mecha-

nism appearing in the child's behavior increases with a higher level of maturity of maternal psychological defense mechanisms. Projection makes it possible to place negative traits and experience outside the boundaries of the "I" and preserves the child's positive self-image. Our research results allow us to conclude that gender influences the formation of a child's individual defense system. Development of male specifics of a defense system is typical for boys. Girls don't have close correlations with the maternal defense mechanisms. At this age, the child successfully interiorizes the maternal example of "seeking and getting support" as a desired strategy, which protects her from threats to her self-identity.

### *Ontogenetic specifics of psychological defenses of children 10–12 years old*

Conditionally, we can define the age 10–12 as pre-pubertal. Some premises of adolescent self-identity crises may already appear at this time. Correlations between maternal and child PDM systems decrease, which could be caused by the child's increasing autonomy, consciousness, and expanding circle of significant persons. The influence of the maturity of maternal psychological defense mechanisms on specifics of the child's defense system declines. A deficit of maternal defensive resources is compensated by the child's own psychological resources.

Correlation between the psychological defense mechanisms of mother and child at the age of 10–12 can be characterized by interiorization of the defenses acquired from conscious maternal teaching. We found correlations between intentional maternal teaching of displacement, compensation, and reconciliation strategies, and the appearance of these strategies in the child's behavior.

Displacement, which means transferring one's reaction to an object that is not able to resist, can appear as a conscious mechanism of expressing negative emotions. In the process of teaching a child displacement, the mother can safely choose an appropriate object for the expression of feelings. At the age of 10–12, the child has the necessary abilities for consciously searching for objects that are appropriate to express the emotions, and avoiding spontaneity and venting negative emotions on family members, pets, and others. Compensation and reconciliation defenses in conflict situations form a base for the child's adaptation in different situations.

The correlation between maternal and child behavior remains strong with respect to intellectualization. At this age, intellectualization becomes actualized in the context of the general development of logic thinking, self-consciousness, and reflection. In general, there is a correlation between the intensity of the maternal and child defense systems. Considerable maternal psychological defenses may be connected with a low level of consciousness and maturity of psychological defense mechanisms; this situation can reveal neurotic symptoms and create intensity in relations between mother and child.

We suggest that the gender factor at this age period substantially influences the correlation between maternal and child psychological defense mechanisms. Boys' defense systems become more autonomous, and maternal influence decreases. Many mothers during the structured interview noted that their sons, at the age of 10–12, claim to be more independent and stronger than earlier, don't feel the need for advice and help, or to share their difficulties with their mother, and have changed a good deal in general. This can be a symptom of increasing autonomy

of the son's psychological defense mechanisms from the mother's. Girls' and their mother's defensive systems correlate. Girls are disposed to interiorize displacement and defensive aggression in the process of maternal teaching

According to our research results, at the age of 10–12, the need for additional support becomes especially great. The child does not feel enough protection from external and internal threats. Acquiring new effective defensive and coping mechanisms is important for her/his ability to manage the situation. This process may be related to the child's maturation and changes in the dominant level of the life-support system. The need for additional support also shows the untenability of some defense strategies and triggers the development of new coping strategies in the next age period.

In this age group, we did not find a correlation between the maturity of maternal psychological defense mechanisms and the specifics of the child's psychological defense mechanisms. Individual factors of personal experience and social environment start to have more influence and the maturity of the mother's psychological defense mechanisms remains secondary.

Therefore, at the age of 10–12, the level of isomorphism of maternal and child psychological defense mechanisms decreases, and gender specifics begin to play a leading role in further formation of defense styles. Discussing and teaching defense strategies become important for the development of psychological defense mechanisms. At this age, the mother needs to be actively involved in the theoretical and practical teaching of defenses, because the child is getting ready to acquire knowledge about defensive behavior through dialogue. The psychological resources of the 10–12-year-old child allow him or her to proceed to the next level of a life-support system: coping.

## **Conclusion**

Our research validates and helps to explain previous research findings about children's psychological defenses. In particular, we validated thesis of J. Bowlby (1982) about the child's attachment to the parents and tendency to take after the parents (as in the imprinting process), relative to the psychological defense system. Our empirical data allow us to suggest that child and maternal psychological defense mechanisms have an isomorphic development. We noted specifics of this isomorphism in different age periods.

Cramer and College (2000) found that the prevailing psychological defenses in school age children are denial and displacement. We have clarified and broadened ideas about possible individual differences in children's prevalent psychological defenses connected with the maternal factor. We found correlations between the maturity of maternal psychological defense mechanisms and specifics of the developing child's psychological defense mechanisms. We conclude that the maturity of the mother's psychological defense mechanisms provides congruence in teaching her child defensive behavior, and defines the prevalent type of reaction to frustration and the instruments of interpersonal defenses. It has maximum significance for children 4–6 years of age, for providing effective adaptation to actual threats to self-identity.

General patterns in the development of a child's defense system which appeared in our research:

1. The child feels maximal stress intensity at age 7–9. This fact may point to the special significance of this age for forming the child's defense system.
2. The child's need for additional support increases at age 10–12, which indicates the necessity of overcoming defensive behavior and rising to conscious levels of self-regulation.

Also we validate and broaden the understanding of the statement of L.S. Benjamin (1974) about defensive and additive reactions of the child to the mother's behavior. We proposed that imitation of and adjustment to the mother's behavior are also typical for developing the child's psychological defense system, and that the individual choice of a child's reaction depends on that child's age and gender.

Each age period gives an individual picture of the child's psychological defense mechanisms and the extent of isomorphism of the defense systems of mother and child. At earlier stages of ontogenesis, the mother's defensive behavior has a dominant role. At 10–12 years, the child becomes maximally sensitive to consciously learning defense strategies, because of the specifics of intellectual development, increasing self-consciousness, and reflection.

Both age and gender play important roles for the ontogenesis of the child's psychological defenses. Gender correlates with the extent of isomorphism of child and maternal psychological defense mechanisms, the child's sensitivity to certain defenses in maternal behavior, and the child's success in learning defense strategies. At age 10–12, a girl's psychological defense mechanisms tend to preserve relationships with those of her mother, whereas a boy's psychological defense mechanisms become relatively autonomous.

*Further scientific investigation* is needed about the influence of both parents on developing the child's system of psychological defenses and coping strategies; about maternal attitudes toward the child, which help to form the child's resistance to stress; about the specifics of stressful situations and coping strategies in one-parent and two-parent families; about creating and refining methods to diagnose the maturity of the maternal psychological defense system and instruments for its development. Also the definition of maturity of the psychological defense system needs further clarification.

## Limitations

This study does not investigate the father's influence on his child's psychological defenses. Only mothers participated in research; we based this decision on the premise that they are the closest adults for a child. The earliest ontogenetic periods are not included in the study, because of difficulties in diagnosing a child's psychological defenses at this age. Taking into account these limitations, we can extend our conclusions about correlations between maternal and child psychological defense mechanisms to the general population of children only in three age groups: 4–6 years old, 7–9 years old, and 10–12 years old, and only if the mother is the closest adult to a child. We investigated correlations, but not cause-effect relations, between maternal and child psychological defense mechanisms, and we focused only on certain parts of the process of developing a child's psychological defense mechanisms in ontogenesis.



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## EDUCATIONAL PSYCHOLOGY

### **Psychological resources of modern Russian adolescents' resilience to violence in the educational environment**

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Determination of the personality's psychological resources that ensure its resilience to negative effects of the social environment is a priority problem in modern society, science, and education, since we currently see a sharp increase in the number of factors that affect psychological hardiness and security. One of these is intensification of violent and aggressive forms of interaction in educational institutions. Such manifestations are especially dangerous in schools, since, by virtue of their age-specific features, students are the most vulnerable and they subsequently translate the acquired values and behaviors to society as a whole. The goal of this empirical study was to identify teenagers' psychological resources that determine their resilience to various forms of psychological violence in the educational environment. The study covered four St. Petersburg high schools, with 437 teenagers aged from 16.5 to 17 (189 boys and 248 girls). A questionnaire was developed to divide the subjects into groups with high and low levels of protection (security) against psychological violence in the educational environment. The questionnaire lists forms of psychological violence in the educational environment (identified by theoretical review) that can occur in interpersonal communication between peers and between teachers and students. The respondents evaluated each item of the questionnaire in accordance with the proposed scale of frequency with which each form of violence occurred. Theoretical analysis determined that psychological violence is traumatic for the adolescent personality's cognitive, emotional, and behavioral spheres. The teenagers' psychological resources of resilience to violence in the educational environment were identified with the aid of psychodiagnostic methods addressing each of them. Our study allows us to conclude that the resources that ensure the teenager's resilience to the negative effect of psychological violence in the educational environment are: satisfaction with oneself, accepting oneself as a personality with positive and socially desirable characteristics; high level of

self-control, well-developed ability to behave in an acceptable way whatever the circumstances; openness and goodwill, self-confidence; perception of the surrounding world as friendly and generous, which gives rise to friendly behavior; holistic perception of the world, experiencing the present moment in one's life in its entirety, striving for personal development and self-improvement; independence of values and behavior from external factors; significance of such values as achievement, self-development, and high financial position, in combination with a priority on learning and education; explanation as a typical mechanism of psychological protection, search for a reasonable basis for justifying behavior and actions as well as impulsive acts; low level of anxiety, aggressiveness, and rigidity. The results obtained can be useful for researching the resource-oriented approach to psychology, and also for the development of follow-up techniques for ensuring the safety of the educational environment, preventing all forms of violence in interpersonal interaction between students and teachers.

**Keywords:** psychological resources, resilience of the individual, psychological violence, educational environment

## Introduction

The study of human resilience to negative effects of the social environment a promising area of modern research. The current interest in this problem is sparked by the ongoing radical social, political, and economic changes in the country (Russia), which affect every sphere of social life, changing the socio-cultural situation as a whole, and sometimes leading to greater social tension and conflict, and more violence in all social systems, including the educational system. Acts of violence against a single person, a group of people, or large communities necessitate a search for resources to promote hardiness and resilience, and identification of people's internal capacities that can ensure their psychological security.

Amid abrupt changes in social and economic life, we find such phenomena as higher mental workload, changes in the values and stereotypes of consciousness, and an increase in violent and aggressive forms of interaction in various social institutions. Such manifestations are especially dangerous in schools, since, by virtue of their age-specific features, students are the most vulnerable and they translate the acquired values, stereotypes, and forms of behavior to society as a whole. The fight against terrorism, which has become the greatest menace today, primarily uses military, economic, and political methods, but of no less importance is an educational system that could efficiently solve prevention, educational and prognostic problems. Reduction of violence in interpersonal interaction in the educational environment promotes the translation of the values of safety and nonviolence to social life.

Violence is traditionally understood as physical or sexual abuse; however, psychological pressure on the individual's personality, infringement of a person's rights and interests, limitation of one's needs and opportunities should also be regarded as acts of violence which, since they are widespread and often not perceived as such, may constitute the greatest danger to personality development. This type of violence is known as psychological or emotional.

In adolescence, unfavorable effects of the social environment are primarily manifested in problems with interpersonal communication and delay in the for-

mation of new personality traits that are normal for this particular age. In many cases the factors that provoke this deformation are varied forms of psychological violence.

Theoretical concepts of violence are distinguished by a great variety of methodological approaches, yet the problem of psychological violence and its consequences for a person's effective functioning remains the least studied. There are virtually no publications that bring to light the individual's internal resources for countering and coping with mentally damaging consequences of psychological violence. There are several reasons for this.

First of all, it was only recently that the consequences of such violence were recognized and there is still no single definition of psychological violence. Secondly, many researchers face problems trying to diagnose it, because it can be durable but nevertheless not recognized by the victim, who may not realize that he or she has been exposed to such violence. Moreover, the initiator of violent actions does not necessarily perceive them as such. In addition, the consequences of psychological violence most often manifest themselves many years later, in the form of deformation of personality traits and behavioral reactions.

Most specialist publications on psychological problems of violence are devoted to violence against the child in the family or in the child's immediate social environment (Alekseeva, 2006; Alekseeva & Novoselskii, 2005; Zinoveva & Mikhailova, 2003). The problems of violence and measures for protecting children left without parental custody and children in the social orphanhood<sup>1</sup> risk group have been widely discussed (Dubrovina, 2000). However, in present-day reality, children and teenagers are more and more frequently themselves the perpetrators of violence against their peers and adults, while teachers and other adults working with children commit (consciously and unconsciously) acts of violence against children. A considerable share of such acts of violence occurs in the educational environment. And while physical, and even more so sexual, violence is condemned morally and prosecuted legally, various forms of psychological violence remain outside the scope of public awareness or researchers' interests.

Researchers state that in Russia there is no uniform approach to defining such terms as *violence* and *cruel treatment*, not to mention *abuse*, *coercion*, *exploitation*, and *battered child syndrome*. In most cases people tend to regard as violence only an insignificant part of the events that damage human health and view it as falling within the purview of criminal law. Volkova (2001), generalizing the findings in the area of problems of violence and cruel treatment of children, formulates appropriate basic definitions. Violence includes all forms of physical and/or emotional cruelty; sexual violence; disregard or disdain; commercial or any other exploitation that leads to real or potential damage to the child's health, life, development, or dignity in the context of responsibility, and trust. Psychological violence means constantly repeated acts of humiliation, terrorization (threats, exposure to danger), or insults. Psychological violence is often described as emotional violence and verbal violence. Emotional and verbal violence are characterized by giving derogatory nicknames, insults, threats of physical violence or harm, shouting and manifesta-

<sup>1</sup> Social orphans are children who had one or both biological parents alive but who were left without parental care and support, or abandoned.

tions of anger, refusal to enter into a relationship (emotional and verbal isolation), pressure or coercion to do what the person does not want to do (Volkova, 2011, pp. 25–26).

In Russian psychological research, the problem of violence and aggressive behavior in schools has been little studied. A few studies touch upon development and support for schoolchildren's personality resources that ensure resilience to the negative effect of violence in the educational environment (Baeva, 2014; Volkova, 2011). Research into psychological problems of resilience focuses on ways of overcoming the adverse effects arising in the process of interaction between an individual's personality traits and unfavorable factors of the social environment.

Resilience research developed from studies of susceptibility to the destructive effect of the environment, such as problems with interpersonal relationships, family problems, or biological problems; then it focused on the factors and processes conducive to the formation of resilience to problems in those areas. The early studies already noted that biological risk factors can be corrected by environmental factors, and that individual characteristics can weaken the effect of unfavorable environmental conditions. Such characteristics include an easy-going temperament and the ability to find support outside the family (Davey, Eaker, & Walters, 2003).

Originally the researchers' efforts were mostly aimed at understanding the pathology thought to be related to the lack of certain qualities or resources, rather than analysis of how the problems were resolved or prevented. The psychoanalytical point of view and the biomedical model, oriented towards identifying the source of pathology in the individual, were dominant in the studies of mental health. However it gradually became clear that such an approach has very limited application. Therefore, unlike studies of mental disorders as consequences of exposure to unfavorable environmental factors, studies of resilience do not focus on risk factors or negative consequences (e.g., illness), but emphasize protective factors instead. The tradition of resilience studies, even though its origin was interest in psychopathology, nevertheless offers an alternative to the deficit-based approach to the study of development under unfavorable conditions (Lam & McBride-Chang, 2007).

As of today, in psychology there is no unambiguous interpretation or definition of resilience, which is defined as a mental process, personality trait, or mental state. Besides resilience, there are other constructs related to "invulnerability" under exposure to risk; the most widespread among them, according to international publications, are hardiness (Kobasa, Maddi, & Kahn, 1982) and coping (Davey, Eaker, Walters, & Matheny, 2003).

Russian studies consider the problem of resilience in the face of unfavorable social environment factors in line with the concept of psychological safety (Baeva, 2014; Zinchenko & Zotova, 2010). Within this framework, the researchers have accumulated ample material related to the human psyche's functioning mechanisms in health-threatening circumstances. The researchers have mainly focused on identifying the personality features that can ensure optimum ways of confronting life's problems. Definitions have been proposed for psychological safety of the individual, such as the ability to "maintain stability in an environment with definite parameters, including exposure to psychotraumatic situations, resilience to destructive internal and external actions reflected in experiencing one's security/insecurity in



a specific situation" (Baeva, Volkova, & Laktionova, 2011, p. 125). The question is posed as to which personality features are the resources that ensure psychological well-being in various life circumstances.

Thus the urgency of studying the teenager's psychological resources that ensure his resilience to violence is conditioned not only by the acuteness of this social problem, but also by the significant contradictions in our conceptions of the nature of psychological violence, man's protective potential for opposing its negative consequences, as well as specific features of these phenomena in the educational environment. Moreover, the effect of psychological violence on personality formation and development has been insufficiently studied.

The goal of this study was to identify teenagers' psychological resources that determine their resilience to various forms of psychological violence in the educational environment.

## Method

The study was conducted in four St. Petersburg schools. It involved 437 high school students, including 189 boys and 248 girls aged from 16.5 to 17 years.

To divide the subjects into groups according to high/low levels of resistance to psychological violence in the educational environment, a questionnaire (*Psychological Violence in the Educational Environment*) was developed, which was tested for content and construct validity.

The questionnaire is a list of manifestations of psychological violence (identified by theoretical review) that can occur in interpersonal communication both among peers and in the teacher-student communication in the educational environment. Each questionnaire comprises 20 items. Examples of peer violence included such items as: "Peers have ignored you for a long time"; "Peers have forced you to do something by threats"; "Peers have humiliated and ridiculed you". Examples of teacher violence were: "A teacher has made you feel that he thinks you're a fool if you don't understand something"; "A teacher has pretended not to notice you"; "A teacher has insulted you and made rude comments about your personality".

Each item was evaluated by the respondents on a four-point ordinal scale according to the frequency of occurrence of the given form of violence.

Data processing was performed by calculating the average score across all forms of psychological violence on the part of students and teachers. The integrative indicator of psychological abuse was calculated by summing up the scores on the two positions and was the basis for the division of the respondents into groups.

Several psychodiagnostic instruments were used to identify the psychological resources of teenage resilience to violence in the educational environment:

- to evaluate *resistance to negative environmental factors*: D.A. Leontiev's adaptation of S. Maddi's Hardiness Test (Leontiev, 2013);
- to identify *psychological characteristics of the cognitive sphere*: Personal Semantic Differential (*Luchshie psikhologicheskie testi*, 1992); Self-Actualization Test; Terminal Values Questionnaire designed by I. Senin (Karelin, 2007);

- to identify *psychological characteristics in the behavioral sphere*: Plutchik-Kellerman-Conte's Life Style Index (Karelin, 2007);
- to identify *psychological characteristics of the emotional sphere*: Eysenck's Self-Appraisals of Mental States Questionnaire (Burlachuk & Morozov, 2002).

*D.A. Leontiev's adaptation of S. Maddi's Hardiness Test.* This instrument reveals the intensity of resilience, understood as an integrative personality structure which is closely linked to success in overcoming difficult situations and to the interaction of an individual with unfavorable conditions as a factor that buffers their detrimental effect. As a personality variable, hardiness characterizes an individual's ability to withstand anxiety arising in difficult situations, while maintaining internal balance and performance level.

The instrument measures the overall level of resilience, which is positively correlated with the set of favorable outcomes, such as good physical health, academic success, ability to withstand professional burnout, etc.

In addition, the methodology makes it possible to identify individual components of resilience: *commitment*, *control*, and *accepting risks*.

*Commitment* is defined as a tendency to involve oneself in all kinds of activities and have a genuine interest in the surrounding world; it also implies the search for meaning and commitment to one's own life goals. *Control* is a tendency to believe and act as if one can influence the events taking place around oneself through one's own efforts. *Accepting risks* (or challenges) is defined as the ability to learn from experience, be it positive or not, considering it as a factor motivating personal growth in new circumstances.

*Personal Semantic Differential (PD)* was developed on the basis of the modern Russian language and reflects our culture's ideas about personality structure. It is aimed at creating a compact and valid tool for studying certain personality traits, self-awareness, and interpersonal relationships, which could be applied in clinical psychological and psychodiagnostic work, as well as in socio-psychological practice.

The PD is formed by a representative sample of words of the modern Russian language describing personality traits, followed by the study of internal factor structure, a kind of "model personality" that exists in the culture and is internalized by each person through the assimilation of social and linguistic experience.

One hundred and twenty words for personality traits were selected from a dictionary of the Russian language. After that, 21 personality descriptors were chosen from this initial set that best characterized the poles of the three classical bipolar pairs of semantic differential: 1) evaluation; 2) potency; and 3) activity.

In the study of self-appraisals, the factor of Evaluation (E) indicates the level of self-esteem; the potency factor (P) indicates the development of volitional aspects of the personality as they are understood by the subject; the activity factor (A) is interpreted as evidence of an extroverted personality.

The *Self-Actualization Test* was developed on the basis of E. Shostrom's Personal Orientation Inventory (POI). POI scales were derived from A. Maslow's theory of self-actualization, and the ideas of F. Pearl and other theorists of existential and humanistic psychology. The test consists of 126 items, each including two judgments

concerning values or behavior. The subject is asked to choose a judgment that most corresponds to his ideas or habitual behavior. The test measures self-actualization on two basic scales and several subscales. The basic scales are: *the scale of time competence (TC) and scale of identification support (I)*. Twelve additional scales are divided into 6 units, each containing two scales:

1. The **Self-Actualizing Value (SAV) and Existentiality (Ex)** scales complement each other to form the unit of values. The first scale describes the values themselves, the second measures the lability of behavior.
2. The **Feeling Reactivity (Fr) and Spontaneity (S)** scales constitute the unit of feelings. The first scale measures the subjects' awareness of their own feelings, while the second determines the extent to which these are manifested in their behavior.
3. The **Self-Regard (Sr) and the Self-Acceptance (Sa)** scales form the unit of self-perception.
4. The **Nature of Man-Constructive (Nc) and Synergy (Sy)** scales constitute the unit of concepts about human nature.
5. The **Acceptance of Aggression (A) and Capacity for Intimate Contact (C)** scales constitute the unit of interpersonal sensitivity.
6. The **Cognitive Needs (Cog) and Creativity (Cr)** scales combine to form the unit of attitudes towards cognition.

*The Terminal Values Questionnaire*, developed by I. Senin, is based on M. Roshch's theoretical ideas about the structure of human values. It aims to diagnose personal life values.

The questionnaire consists of 80 statements, each to be evaluated by respondents on a 5-point scale (irrelevant — 1, of small value — 2, of some value — 3, important — 4, very important — 5). The results are presented in the form of individual profiles, separately for the scales of life values (8 values) and life spheres (5 spheres).

The data obtained help to assess both the overall intensity of each of the eight life values, and its representation in various spheres of human life.

The eight *life values* are:

1. Prestige — gaining recognition by following certain social requirements;
2. High financial position — regarding material prosperity as the primary purpose in life;
3. Creativity — realization of one's own creative potential, desire to change the environment;
4. Active social contacts — establishing favorable relationships in various domains of social interaction, expanding one's interpersonal relations, performing one's social role;
5. Self-development — being aware of one's own individual characteristics, developing one's talents and other personal characteristics;
6. Achievements — regarding the task of solving certain life problems as a priority;
7. Spiritual satisfaction — being guided by moral principles, spiritual needs prevailing over material needs;

8. Maintaining personal identity — one's own opinions, attitudes, and beliefs prevail over conventional ones; the uniqueness and independence of the self is preserved.

The five *life spheres* are: professional life, training and education, family life, social life and hobbies.

The *Life Style Index* questionnaire was developed in 1979 on the basis of R. Plutchik's psychoevolutionary theory and H. Kellerman's structural theory of personality. This method makes it possible to diagnose the system of ego defense mechanisms, to reveal the leading basic mechanisms, and to assess the degree of tension in each of them. The instrument comprises 92 questions, allowing us to define eight scales: denial, displacement, substitution, compensation, overcompensation, projection, and rationalization.

Eysenck's *Self-Appraisals of Mental States Questionnaire* allows evaluating the levels of the four emotional states: anxiety, frustration, aggressiveness, and rigidity. Test items consist of 40 statements. Respondents are asked to identify their own mental states by assigning to each statement a score — 3 points if appropriate; 2 points if this condition is rare; 1 point if inappropriate.

The empirical data were analyzed using the following statistical methods:

- Evaluation of selected parameters of the distribution of a trait (mean values, variance, standard deviation) for a general description of the research results, evaluation of average norms, and the overall psychological portrait of the samples within the parameters laid down in the program of study;
- Student's t-test — to assess the differences in the mean values.

We used the software package STATISTICA 12.0.

## Results

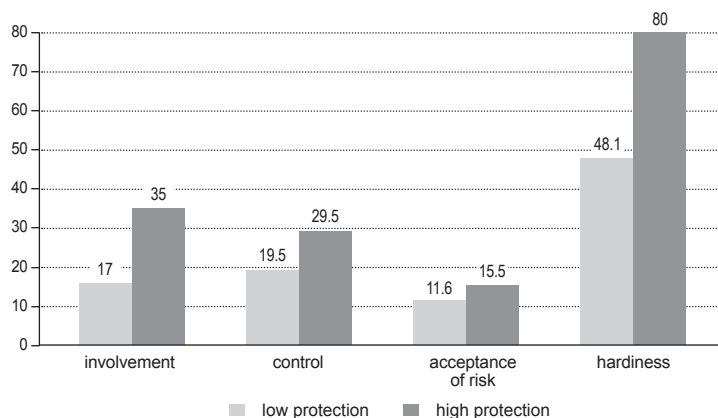
Our findings show that in general, the teenagers who feel a low level of security or protection ("low-level-security teenagers") have a lower hardiness level compared to the "high-level-security teenagers".

The high level of hardiness for high-level-security teenagers prevents the occurrence of inner strain in stressful situations, due to the ability to firmly cope with stresses and perceive them as less significant. The hardiness of high-level-security teenagers invigorates them and motivates them towards self-realization, leadership, a healthy way of thinking and behaving. It gives them an opportunity to feel significant and valuable, to solve complex situations in reality despite the existence of stressors.

By comparing all the test metrics using Student's t-test, we found that the two groups of teenagers differ in their level of expressivity of each hardiness component, as well as in their hardiness level as a whole. These differences are significant (for all  $p \leq 0.01$ ). The data obtained are given in Fig. 1.

Comparative analysis reveals significant differences in the involvement between the groups ( $t = -6.45, p \leq 0.01$ ). The results indicate that the low-level-security teenagers possess a less developed involvement component compared to the high-level-security teenagers, which makes them less capable of enjoying their activity. They feel rejected and "left out of life" more often. This feeling probably becomes

fixed in their personality traits, making them more withdrawn. So, a vicious circle is formed, when the teenager's system of beliefs and personality traits generate a certain behavior which, in turn, promotes formation of relationships with people around him or her that will further solidify these beliefs.



**Figure 1.** Expressivity of the average values of hardiness and its components in groups of teenagers with low and high security (protection) levels

The results of our experimental studies indicate that the low-level-security teenagers possess a less developed component of control ( $t = -5.83$ ,  $p \leq 0.01$ ) compared to the high-level-security teenagers. This makes it possible to claim that high-level-security teenagers have a stronger perception that they choose own their activities and their path, in comparison with low-level-security teenagers, who experience powerlessness, the impossibility to influence the results of what is going on, the futility of any effort.

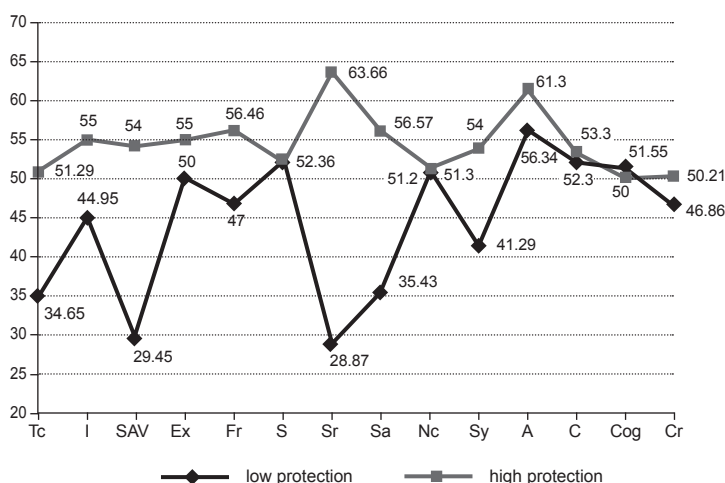
Comparing the average expressivity of the control component in the groups mentioned above, it was found that the low-level-security teenagers possess a significantly lower level of control ( $t = -4.24$ ,  $p \leq 0.01$ ). The data enable us to conclude that teenagers' firm conviction of the impossibility of influencing what is going on, typical of the low-level-security subjects, affects their behavior, minimizing their activity and attempts to change anything. Such people "forecast" failure, make fewer efforts, and, as a result, achieve less success. The absence of progress reinforces the conviction that all kinds of activity are useless. But the high-level-security teenagers are confident that they can influence a situation and treat it as less traumatic; they are more active in trying to change it, which leads to greater success. This attitude solidifies the appropriate belief system and motivates them to search for ways to influence the results of stressor-induced changes, as opposed to the state of helplessness and passivity typical of the polar group of subjects.

The study results prove that the low-level-security teenagers have a less developed component of risk-taking (described as the conviction that everything happening to a person promotes his or her development through knowledge gained by experience, whether positive or negative). The polar group of teenagers to a greater degree considers life as a way of gaining experience; they are ready to act without guaranteed success, at their own risk. They display self-confidence and determination when making choices in different reality situations. The high level of hardiness

enables them to bear more easily the anxiety that accompanies any choice, opting in favor of uncertainty rather than certainty. This well-developed component of hardiness helps them remain open to the environment and society, to treat reality situations as tests and challenges. Quite the reverse, the low-level-security teenagers are anxious for assured results, comfort and safety; they find alien the idea of developing through gaining knowledge from experience and application of that knowledge.

Comparison of the study results obtained by using the Personal Differential technique detected differences in two statistically significant scales — the “estimation” scale ( $t = 5.32, p \leq 0.01$ ) and the “activity” scale ( $t = 2.34, p \leq 0.05$ ). It was established that the low-level-security teenagers possess lower self-esteem, and are more introverted than the high-level-security teenagers.

Comparison of the study results obtained by using the Self-Actualization Test is given in Fig. 2. Reliable differences were determined according to four statistically significant parameters. It turned out that the low-level-security teenagers possess lower indices: the “support” scale ( $t = 6.37, p \leq 0.01$ ), the “value system” scale ( $t = 4.71, p \leq 0.05$ ), the “self-esteem” scale ( $t = 5.61, p \leq 0.05$ ), and the “self-acceptance” scale ( $t = 4.23, p \leq 0.05$ ).



**Figure 2.** Results of the study of parameters according to the Self-Actualizing Test in groups of adolescents with low and high levels of security (protection)

Analysis of the results proves that the high-level-security teenagers possess a greater degree of independence in their actions, strive to follow their own goals, persuasions, and standards; typical for them is the ability to value their own advantages; they accept themselves the way they are. The higher the security indices, the higher the self-acceptance and self-esteem levels, and the better their capability for demonstrating independence in their actions, regardless of external factors.

Analysis of terminal values and overall life spheres established that the high-level-security teenagers typically had a greater interest in self-development ( $t = 5.32, p \leq 0.05$ ), as well as in achieving high results in the social sphere ( $t = 4.73, p \leq 0.05$ ). Learning and education are more important to them than to the low-level-security teenagers ( $t = -3.22, p \leq 0.05$ ), while the low-level-security teenagers demonstrate



significant concern about preserving their individuality compared to the high-level-security teenagers ( $t=2.64$ ,  $p\leq 0.05$ ).

Significant differences were identified after comparing the results according to four parameters of psychological defense — projection, compensation, hypercompensation, and rationalization: Higher indices of defensive tension are typical for the low-level-security teenagers (Table 1). The high-level-security teenagers tend to use compensation ( $t=-4.31$ ,  $p\leq 0.01$ ) and rationalization ( $t=-5.12$ ,  $p\leq 0.01$ ) as defense mechanisms, whereas the low-level-security teenagers use projection ( $t=6.64$ ,  $p\leq 0.01$ ) and hypercompensation ( $t=3.74$ ,  $p\leq 0.05$ ). Thus, the low-level-security teenagers possess less constructive means of responding to stressful situations.

**Table 1.** Security intensity in groups of adolescents with low and high levels of protection (security) from violence in the educational environment

Scale	Average values in the group with low level of security	Average values in the group with high level of security	Reliability of differences (Student's $t$ criterion)
Exclusion	27.3	24.4	2.74
Regression	27.61	25.3	2.36
Substitution	37.6	36.4	1.03
Negation	26.35	22.81	3.25
Projection	59.7	32.5	6.64**
Compensation	29.82	38.13	-4.31**
Hypercompensation	36.21	32.28	3.74*
Rationalization	21.3	42.2	-5.12**

\* significance level  $p\leq 0.05$ ; \*\* significance level  $p\leq 0.01$ .

Comparative analysis of the emotional states in both teenage groups shows that virtually all the indicators in the low-level-security group are higher. Reliable differences at a statistically significant level were discovered on the “anxiety” ( $t=3.27$ ,  $p\leq 0.05$ ), “aggressiveness” ( $t=6.73$ ,  $p\leq 0.001$ ), and “rigidity” ( $t=6.84$ ,  $p\leq 0.001$ ) scales. We can state that the low-level-security teenagers are more anxious, aggressive, and rigid in the educational environment.

## Discussion

To summarize, it can be stated that teenagers with a low level of psychological security from violence in the educational environment enjoy their own activity less than teenagers with a high level of psychological security. They more often have the feeling of being rejected or “left out of life”. Teenagers with a high level of psychological security feel that they choose their own activities and their own way in life to a greater degree than do teenagers with a low level of psychological security, whereas the latter more frequently feel impotent, unable to influence what is happening around them, that their efforts are futile.

Teenagers with a low level of psychological security have a less developed component of risk taking, i.e., they are not convinced that everything that happens

to them promotes their development due to the knowledge gained from their experience, both positive and negative. Teenagers with a high level of psychological security regard life as a way to gain experience to a greater degree. They are more frequently willing to risk acting in the absence of reliable guarantees of success. They show greater confidence and decisiveness while making their choice in various reality situations. The high hardiness level of teenagers who feel protected enables them to survive more easily the anxiety that follows a choice made in favor of uncertainty rather than certainty. Obviously, the phenomena of low and high security from psychological violence in the educational environment are closely connected with the person's hardiness.

Teenagers with a low level of psychological security have lower self-assessment; they are more introverted than teenagers with a high level of psychological security.

Teenagers with a high level of psychological security are characterized by a greater interest in their self-development, in achieving results in society. Learning and education are more significant for them, while teenagers with a low level of psychological security show a greater interest in maintaining their own individuality than do teenagers with a high level of psychological security. The results confirm that psychological violence affects teenagers' life goals and the reference points in their general view of the world. With decreasing psychological security come suspicion and egocentricity in the teenager's personality traits.

Analysis of the empirical characteristics established that teenagers with a high level of psychological security more often use compensation and explanation as defense mechanisms, whereas teenagers with a low level of psychological security resort to projection and hypercompensation. This means that teenagers with a low level of psychological security possess less constructive ways of responding to stressful situations. Teenagers with a low level of psychological security express their emotional state more strongly. They are more anxious, irritable, and aggressive, being less inclined to change their behavior, beliefs, and viewpoints.

Our research enables us to assert that the resources that provide the teenager's resistance to negative effects of psychological violence in the educational environment are the following:

- self-satisfaction, perception of oneself as a personality possessing positive and socially desirable characteristics;
- high self-control, a well-developed ability to stick to a chosen line of behavior regardless of the circumstances;
- openness and kindness, self-confidence;
- perception of the world as friendly and generous, which generates friendly behavior;
- holistic perception of the world, experiencing the present moment in its entirety, striving for self-development and self-perfection;
- independence of values and behavior from external factors;
- significance of such values as "achievement and self-development" and "high financial status", combined with a priority accorded to learning and education;
- explanation as a typical mechanism of psychological security, search for a reasonable basis for justification of behavior, activities, and impulsive acts;
- low level of anxiety, aggressiveness, and rigidity.

## Conclusion

Violence in the educational environment is becoming an ever more severe international problem, with its aspects widely discussed. All manifestations of violence must encounter resistance, as they destroy the values underlying democratic society (Forsman, 2006). The term used in international psychology research to describe violence against the individual personality in the educational environment is "bullying". Also used is the term "school violence", which describes abuse involving the use of force (coercion, including psychological coercion) by children among themselves, by teachers towards a student, and by students towards a teacher. Ordinary invisible but constantly repeated action violates the requirement of personality immunity and leads to suppression, oppression that affects well-being. If it is impossible to resist violence, it can cause "burnout" of the psychical activity. Children learn best of all in conditions under which they feel safe. Bullying devalues, isolates and scares people so much that they lose confidence in their own abilities. Every student has the right not to be exposed to violence or bullying during the whole day in the classroom and outside it. It is considered to be the responsibility of the whole school community to protect the child's right to have a feeling of safety at school (Fonagy, 2005).

To provide security from violence, it is vital to decrease it in the environment, which is an urgent social task. Integration and development of a person's inner resources to resist negative external influences are significant as well. This can be achieved with the help of psychological counseling and implemented in the educational environment, in order to translate the values of non-violence and security to the wider social context.

As shown by the empirical research, the necessity to counteract teenagers' manifestations of psychological violence in the school environment assumes that they possess certain psychological resources, which include hardiness as an integral personality education, which facilitates the overcoming of difficulties, and emotional, cognitive and behavioral sets represented by the relevant characteristics.

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## The role of teacher-child interaction in promoting peer communication

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It is well-known that communication is the main source and necessity of human development and activity. It promotes social relationships, self-image and a wide range of cognitive and non-cognitive skills. Preschoolers communicate both with their peers and adults. It is traditionally assumed that peer communication greatly depends on the teacher-child interaction, leading role of the adult, and the child's own activity, which are the main elements of the Russian preprimary education system.

Changes in social situations, reductions in available play time, greater engagement of children in activities and many other factors can affect modern preschoolers' peer communication. Therefore, the effect of teacher-directed and child-directed teacher-child interactions on preschoolers' peer communication important to study.

The following methods were applied: peer-communication observation, the behavioral tests 'Magic room' and 'Mosaic', and the sociometric procedure 'Two houses'. The sample included 49 Moscow preprimary students aged 4 to 6 year old (25 girls and 24 boys).

The research proved that preschoolers showed better results in child-directed interactions, such as playing skills, compared with a similar situation in which the children were directed by the teachers. Additionally, the level of proactiveness, communication success, conflict resolution, prosocial behavior and emotional response to peer influence did not differ among children.

Thus, the child-directed approach is more beneficial to preschoolers' communication development than a teacher-directed approach.

**Keywords:** teacher-child interaction, preschoolers' peer-communication, peer-communication components, preprimary education

## Introduction

### *Peer-communication is an important part of preschoolers' development*

According to the Federal Educational Standards (Federal State educational standard of preschool education, 2013), the aim of preprimary education is to provide autonomy, independence, responsibility, initiative and other social-emotional skills. One of the most important educational targets is highly developed communicative competence and abilities, particularly in peer-communication. The importance of peer-communication in preschool childhood is obvious. It can have a favorable effect on developing cognitive skills, pro-social behavior, emotional comfort and so on. Intensification of peer-communication in preschool childhood provides high educational outcomes. It is important to incorporate and coordinate various perspectives and accumulate knowledge in developing communication skills during childhood (Tartas, Baucal, Perret-Clermont, 2010; Flavell, 1981).

Peer-communication ensures critical thinking, objectivity and reflexivity. Communication is a predictor of cognitive development. Moreover, peer-communication fosters prosocial behavior, prevents bullying and contributes to a favorable emotional climate in class (Eisenberg, Mussen, 2011). Therefore, it is important to determine how to develop and research the role of teacher-child interactions in the formation of peer-communication during childhood.

According to L.S. Vygotsky, peer-communication is an objective necessity in child development (Vygotsky, 2008) and a special activity. Interactions with others and self-image depend on it. Communication and relationships can be developed by playing with peers (Smirnova, Kholmogorova 2005; Zaporogets, Lisina, 1974).

Preschooler's peer-communication is complicated and is a holistic system with special strict and evolutionary dynamics. At the age of 5-7 years, children's relationships become more selective and stable. At this stage, there are stable groups of friends. Preschoolers tend to spend more time playing and talking with peers. Peers' opinion and access become very influential. Preschoolers attach to each other and have stable attractions and preferences. The group of peers becomes diverse, and it is possible to have different stable groups of friends and to access a sociometric structure.

Preschoolers' peer-communication can be analyzed by assessing proactiveness, favorable positions, successful communication, playing skills, frequency of conflicts, conflict coping method, behavior during conflict, sociometric structure of the group, pro-social behavior and emotional involvement in peers' actions (Smirnova, Kholmogorova 2005; Zaporogets, Lisina, 1974; Smirnova, Galiguzova 2005).

Proactiveness is a child's ability to create clear ideas and various proposals for cooperative play. Successful communication depends on how many partners the child chooses for imaginative play. Playing skill is the ability of a child to engage in role-playing games or a game with rules, assign roles, and perform them consistently to expand the game's plot. The frequency of conflicts is the number of conflicts that include the child. Conflict coping methods involve the successful choice of the method of conflict resolution. The sociometric structure of the group involves a relationship of sympathy or antipathy within the group. Pro-social behavior is a child's means of communication with children, contributing to the successful organization of joint activities. Emotional involvement in the peers' actions



means the desire and willingness of the child to perceive the actions of peers and to respond to his proposal.

Changes in the general social situation, shifts in educational and training priorities, reduction in time allocated to play and for free activities, and the emergence of new methods of interaction, including computer games, a large engagement of children and many other factors affect the dialog of modern preschool children with their peers and their ability to choose their partners, to organize joint play and other activities, to resolve conflicts, to understand other people, and so on (Smirnova, Galiguzova, 2005; Sobkin, Skobeltsina, 2012; El'koninova, 2014). In this regard, the role that this process plays in the educational environment of preschool institutions, in which children spend most of their time, is important. It is traditionally assumed that peer-communication development highly depends on the conditions of upbringing. International studies have shown that early educational experience is very important for further wellbeing (McCain M., Mustard J.F., 1999). Daily practice of pre-school education helps to achieve the required level of social development.

Additionally, most children spend a major part of their day in a preschool institution that is associated with the experiences and interests of the child. According to the ecological approach, taking into account the role of this field in the real life of the child will enable significant progress in preschoolers' development and well-being (Pianta, Rimm-Kaufman, & Cox, 1999). Daily practice of pre-school education helps to achieve the required level of intellectual, personal and social development.

Research on pre-school education quality was the subject of multiple publications in recent years, gaining widespread popularity after the article by George Hackman in 2006. In that article, he demonstrated the importance of kindergarten as a whole and the quality of educational programs in particular. The mere fact of attending kindergarten (or other pre-school organizations) has been recognized as beneficial for the child, contributing to his future success and well-being (Heckman, Tremblay, 2006).

Nevertheless, the exact "driving force" in this effect remains insufficiently disclosed. The current debate is what comprises a high quality pre-school education.

### ***Teacher-child interaction in preschool childhood***

The importance of the teacher-child interaction, leading role of adults, and significance of a child's own activity are basic theoretical frameworks on which Russian preprimary education is based. The importance of the child-adult interaction has been highlighted in the fundamental basic theory of development and education (Vygotsky, 2008; Polivanova, 2012).

Effective teaching in early childhood education and care (ECEC) should include sensitive and warm interactions, responsive feedback, and verbal communication, and preference should be given over the structured and highly regulated approach.

A not overly structured interaction provides good results in literacy and social development (Downer, Sabol, Hamre, 2010). Trust and a close teacher-child interaction can decrease aggressiveness and provide pro-social behavior (Birch & Ladd,

1988; Graves, Howes, 2011; Locasale-Crouch, DeCoster, Pianta, 2013). Recent research has also demonstrated associations between the teacher-child interaction and school-readiness. Good teacher-child interactions provide high scholastic achievements (Scott-Little, La Paro, Thomason, Pianta et al., 2011).

The teacher-child interaction is an important condition of preschooler development. It occurs in preprimary settings based on various approaches (teacher-directed or child-directed).

### ***Models of teacher-child interaction***

Based on the findings of V. A. Petrovsky, we have identified several patterns of interactions between the teacher and child: the “non-interference”, educational-disciplinary and personality-oriented models (Petrovsky, 1996).

“Non-interference” model. In this model, the teacher stays indifferent to the child, sees him or her as an interference, does not provide support and avoids responsibility.

“Educational-disciplinary” model of interaction. The purpose of this interaction is to enlighten the child with knowledge, skills and abilities. In this model, the child is a passive object of the adult’s influence and only adjusts to him. Typical methods of interaction in this model are punishment, prohibition, instruction, explanation or threat.

In foreign studies, a similar model is called teacher-directed interaction. In this report, we will use these terms interchangeably.

Recent research has proven that the teacher-directed interaction provides better learning, motivation and language development for low-income preschoolers. The children showed high task performance as well as positive emotions and affect at the end of the test (Anders, 2014). Teacher-managed activities had a positive effect on the development of language, literacy and mathematical skills in preschool children (De Haan, Elbers and Leseman, 2014). Children showed relatively low results in motivation measures (dependency on adults, self-esteem, beliefs in the success of their own accomplishments) (Stipek, Feiler, Daniels et al., 1995).

The teacher-directed teacher-child interaction can successfully promote children’s learning, but the effects often seem to be short-termed and may diminish very quickly (Kuger, Sechtig, & Anders, 2012).

Personality-oriented interaction model. The teacher seeks to provide the child with a sense of psychological security and confidence in the world and to develop his personality. The child is an active participant in the interaction. A typical interaction is a partnership dialogue, promotion of independence, activity stimulation, and use of problematic situations. This model is often described as the child-directed model of interaction and assumes relationships of cooperation and partnership between adults and children, a combination of the goals of individualization and socialization. The teacher-child interaction is characterized by goodwill, an individual approach, and promotion of freedom and educational initiatives of children and excludes punishment (Rubtcov, 2005; Bulichova, 2012). Recent research has proven that the child-directed interaction provides a wide range of benefits. Marcon (1999) showed positive effects in acquiring basic, receptive and language skills as well as personal and interpersonal skills. The study by Lerkkanen and colleagues

found that a child-directed model of interaction was positively associated with the development of children's interest in reading and mathematics (Lerkkanen and colleagues, 2012).

Children who took part in preschool programs that used the child-directed teacher-child interaction model demonstrated higher self-efficiency and self-esteem on academic achievement, were less independent on adults, were more proud in their own accomplishments and were less worried about school later. Therefore, in regard to socio-emotional factors that later affect academic achievement, the child-directed teacher-child interaction model seems to be highly effective.

The study of the connection between the teacher and child as well as the development of peer-communication has not received substantial attention. Therefore, it is the aim of our study.

## **Method**

A procedure to detect significant differences by using the Mann-Whitney test was used to analyze the results (significance level = 0.05). These methods were used to estimate indicators, including peer-communication, proactiveness, favorable position, successful communication, playing skills, frequency of conflicts, conflict coping method, behavior in a conflict situation, sociometric structure of the group, and pro-social child behavior and emotional involvement in peers' actions (Smirnova, Kholmogorova 2005; Zaporogets, Lisina, 1974; Smirnova, Galiguzova 2005).

The following methods and procedures were used for the peer-communication study: "Magic room", "Two houses" (Lavrentieva, 2002), observation of children's communication in play situations and free activity, and "Mosaic" (Smirnova, Kholmogorova, 2005).

The "Magic room" procedure is designed to explore proactiveness, successful communication and the development of playing skills and behavior in a conflict situation (frequency of conflicts, conflict coping method).

*Procedure.* According to the instructions, children are told to imagine that they find themselves in a magic room that contains various games and toys. To get there, they have to observe two conditions: choose two children whom the child will take with him/her and propose what they will do in the magic room.

The psychologist records the child's choice for his/her partners (the number of partners, their age, relationships with the chosen partners: whom he/she is acquainted with or related to). The psychologist also requests that the child suggest an activity.

Then, the psychologist tells the child that his partners are bored and asks the child what he/she is going to do next. The most important factor to determine is how the child reacts to the frustrating situation he/she is faced with. This procedure is repeated three times. At the end of the session, the psychologist thanks the child and praises him/her for his/her creative approach.

*Interpretation.* The child's initiative and his/her attitude is evaluated on a 4-point scale (0 to 3 points) according to the activities proposed by the child, their variety, the roles he/she has taken (a leader or secondary role), the way the child enjoyed the leading role of the communication, and his/her reaction to the imaginary conflict situation that is imposed on the child at the end of the session.

0 points	Child does not demonstrate any initiative and does not propose any activity
1 point	Child proposed not more than 1 game, was not persistent and preferred secondary roles
2 points	Child proposed one or two games and enacted secondary roles
3 points	Child demonstrated the highest initiative, proposed two or more games, chose the role of the leader and insisted on their point of view

Success in communication is evaluated based on the number of partners the child has chosen and their characteristics. Special attention is paid to the ability of the child to name two or more partners and whether the chosen partners happen to be his/her peers or adults, belong to his/her group or strangers if they are his/her relatives. The psychologist also records if the child has chosen popular or not popular partners, imaginary partners or animals.

0 points	Child does not know whom to choose and plays individually
1 point	Child experiences difficulty in making a choice and names one partner, mainly a grown up, a relative, or older or not popular children
2 points	Child chooses two children of their own age (at least one of them from the kindergarten group)
3 points	Child immediately names two or more children from their group and offers several additional partners after being questioned by the psychologist.

The development of playing skills is assessed based on the child's ability to propose several variations of a game, invent a storyline, and share roles.

0 points	Child cannot propose any game or chooses manipulative games or destructive actions
1 point	Child proposes one game, mainly a table game, and finds it difficult to name any other possible variations
2 points	Child proposes one or two variations of socio-dramatic play or a game with rules in which several children take part
3 points	Child easily offers multiple variations of games and is able to talk about the turns, rules and participants

The manner of the child's behavior is assessed on a 3-point scale (1 to 3 points) in an imaginary conflict situation (resistance to continue his/her game), constructive or destructive.

1 point	Child demonstrates only destructive ways of solving the conflict (showing aggression, trying to escape, asking for assistance from a grown-up)
2 points	Child is ready to have a constructive dialogue but wants his/her partner to come up with a decision
3 points	Child intends to resolve the conflict constructively, for instance, by offering another game

The “Mosaic” method is used to examine the pro-social child’s behavior and emotional involvement in the peers’ actions.

*Procedure.* Two children take part in the game; each receives a field for a mosaic and a box with colorful elements. Children are asked to race to make mosaic suns on their fields. One of the participants receives mostly yellow elements in his box, and the other receives blue elements. Soon after they start, one of the children notices the lack of yellow elements. In this situation, the child has to ask his peer for help (to give him/her the missing yellow elements). After both of the suns are ready, the psychologist asks them to make a mosaic of the sky above the suns. This time the child faces the lack of blue elements.

*Interpretation.* The prosocial factor is important. A higher score demonstrates prosocial behavior, which is manifested in the child’s ability and willingness to help his peer and provide him with his element of the mosaic, even if he needs it himself.

0 points	Child refuses to share his elements of the mosaic even after numerous requests
1 point	Child shares his elements unwillingly under pressure from his peer and obviously expects gratitude and emphasizes his help
2 points	Child does not refuse to help, but only offers after finishing his/her own task
3 points	Child offers the peer his/her elements without any resistance

Emotional involvement in peers’ interactions is assessed by the ability of the child to consider the intention of another child and to respond to his/her proposals and feelings. Emotional involvement can be evaluated as positive, negative or demonstrative.

0 points	Child ignores other’s actions and does not react to them
1 point	Child gives negative estimations (abuses or laughs at his/her peers)
2 points	Child treats his/her peers with defiance
3 points	Child gives positive evaluations and advice and suggests and helps the other child

The “Two houses” method is oriented to reveal the sociometric structure of the group and attractive relationships of children.

*Procedure.* Two houses are shown to a child (one is red and the other is blue). Then, the child is asked to choose his/her peers from his kindergarten group. Those with whom the child wants to live with are placed in the red house, and the blue house is filled with those whom the child does not want to live with.

*Interpretation.* Based on the acquired data, the sociometric structure of the group is constructed and the sociometric status, sympathies and antipathies of each child are defined.

The observation of the children’s play communication and free activity is used to obtain preliminary data on the child’s communication with peers under natural conditions. Proactiveness of communication was estimated according to the following criteria:

0 points	Child did not make any propositions to his peers
1 point	Child seldom agrees to join games and activities or agrees to play roles proposed by others
2 points	Child proposes games and/or other activities and is prepared to take leading or secondary roles
3 points	Child is proactive all the time and is able to insist on his/her point of view and arrange various games and activities

Analysis of the frequency of conflicts in which children took part was performed using observation. The observation was conducted for three hours over several days.

0 points	The number of conflicts in which the child took part exceeded 3
1 point	Child took part in 2–3 conflict situations
2 points	The average number of conflicts did not exceed 1–2
3 points	Child was not observed in conflict situations at all

### **Sample**

The sample included 49 Moscow pre-primary students aged 4 to 6 years old (25 girls and 24 boys).

Twenty-five children attended a private pre-primary institution where the child-directed approach predominates, and the average age of the children was 5 years 1 month.

Many teachers actualize their own education programs in their interactions with children. A conventional system is missing, free zones are allocated to freedom to play, and much time is spent playing and performing other efficient activities. Twenty-four children attended state kindergarten with a teacher-directed approach. Two main teachers interacted with the children according to certain education programs, and the curriculum was based on state standards. Most of the time is spent on specially arranged activities.

Hereafter, the following definitions will be used: sample 1 — children from a child-directed approach pre-primary school; sample 2 — children from a teacher-directed approach pre-primary school.

## **Results**

### ***Characteristics of the development of preschool child communication***

#### ***Proactiveness***

The level of proactiveness of children in both subsamples was determined as low, medium and high (Sample 1 — average score 2.2 points; Sample 2 — 1.7 points). Thirty-six percent of children were in a passive position. They refused to play and were not able to make any proposition spontaneously, did not take part in games and activities with other children or passively agreed to play roles offered by other children. These roles were secondary and non-active.



	Sample 1	Sample 2	U <sub>emp.</sub>	U <sub>0,05</sub>
Level of proactiveness	2.2	1.7	53	34–46

Thirty-six percent of children demonstrated a subdued position. They could propose one or two game alternatives in which they were only passive participants. Their comments over the course of the game were mostly insignificant and connected only with their own role.

The dominant position was taken by 28% of children. They were leaders in the play situation, preferred to take dominant roles and described the course of the game and distribution of roles.

### *Communication success*

The following results were obtained for the indices of communication success (Sample 1 — average score 2.5 points; Sample 2 — 2.9 points). Seventy-six percent of children were successful in communication; they found more than two peer partners both in an imaginary situation and in real life. Twenty percent of children demonstrated relative comfort. It took them quite a long time to make their final choice, and their preferable communication partner was usually their brother/sister or a neighbor, but not a child from the group. Only 4% were not successful in communication. They either refused to name their game partner or preferred to play with animals or parents.

	Sample 1	Sample 2	U <sub>emp.</sub>	U <sub>0,05</sub>
Communication success	2.5	2.9	47	34–46

### *Development of playing skills*

The development of playing skills in the reviewed samples was the following (Sample 1 — average score 2.4 points; Sample 2 — 1.3 points): 56% of children demonstrated a low level, were not able to propose a game, and chose manipulative or destructive actions. Twelve percent of children demonstrated a medium level of development of playing skills. They were able to propose one or two alternatives of socio-dramatic play or a play with rules and imagined development of the plot. Thirty-two percent of children possessed a high level of development of playing skills. They proposed several alternatives to socio-dramatic play, play with rules or dramatization play; described the course of the play and distribution of roles; and developed the plot consistently.

	Sample 1	Sample 2	U <sub>emp.</sub>	U <sub>0,05</sub>
Development of playing skills	2.4	1.3	31	34–46

### *Frequency of conflict situations*

The frequency of conflict contacts and behavior in conflict situations were analyzed.

The frequency of conflict contacts under natural conditions in both subsamples was low (Sample 1 — average score 2.11 points; Sample 2 — 1.85 points).

	Sample 1	Sample 2	$t_{emp.}$	$t_{0,05}$
Contacts in conflict situations	2.11	1.85	0.8	2.05–2.76

Analysis of conflict resolutions in an assumed and in a real situation demonstrated that the majority of children (60%) preferred a constructive approach and tried to come to an agreement that would be suitable for both partners, 28% of children ignored the conflict, and 12% of children behaved aggressively or abused and even threatened their partner (Sample 1 — average point 2.4; Sample 2 — average point 2.6).

	Sample 1	Sample 2	$U_{emp.}$	$U_{0,05}$
Conflict resolution approach	2.4	2.6	67	34–46

### *Prosocial behavior*

Prosocial behavior was recorded during observation of joint activities of children (Sample 1 — average score was 2.57 points; Sample 2 — 2.35 points). Sixty-one percent of children rendered positive altruistic assistance and offered their partner the use the elements of their own mosaic. Thirty-two percent of children acted pragmatically and shared their elements after their partner's request, but only after finishing their own task. Seven percent of children refused to help their partner verbally, but did not prevent the partner from taking the missing elements. No categorical refusal of helping another child was registered.

	Sample 1	Sample 2	$U_{emp.}$	$U_{0,05}$
Prosocial behavior	2.57	2.35	97	47–61

### *Emotional response to peer influence*

An emotional response to peer influence was reviewed as the willingness and readiness of the child to perceive actions and react to other participants' propositions. In both Sample 1 and Sample 2, children demonstrated a medium level of response (i.e., did not always respond emotionally to actions and propositions of other children) (Sample 1 — average score 2.2 points; Sample 2 — 2.31 points).

	Sample 1	Sample 2	$T_{emp.}$	$T_{0,05}$
Emotional response to peer influence	2.2	2.31	0,5	2.05–2.76

### *Sociometric structure of the group*

Analysis of the sociometric structure of the group demonstrated the relations of sympathy/antipathy among the children. Overall, the total percentage of positive

responses in both samples was 72.5% and, negative responses amounted to 27.5%. In most cases, children experienced serious difficulties in explaining the reasons for their sympathy or antipathy. Most commonly, children gave brief answers, for instance: “we are friends”, “we are not friends” or “I don’t know”.

### ***Peer-communication quality in teacher-directed and child-directed approaches***

We compared the peculiarities of communication of children who attend pre-primary school with child-directed and teacher-directed approaches. The following indices were measured: proactiveness, success in communication, development of playing skills, frequency of conflict contacts and ways of resolving conflicts, prosocial behavior, emotional response towards peer influence, and sociometric group structure. Significant differences among subgroups were indicated at various levels of development in playing skills and sociometric group structures ( $p \leq 0.05$ ).

The development of playing skills of children from Sample 1 and Sample 2 were significantly different. The skill of entering socio-dramatic play or a game with rules, distributing roles, following them and developing the play’s plot consistently were higher in Sample 1. Children from Sample 2 proposed fewer variations of socio-dramatic play, could not explain the course of the game as well, and the rules were also more complicated for them. They usually proposed the same set of games: cars, dolls, and so on (Sample 1 — the average number was 2.4; Sample 2 — the average number was 1.3 according to 3-point scale from “1” to “3”). According to the results, these differences were significant based on the Mann-Whitney U-test ( $p \leq 0.05$ ).

	Sample 1	Sample 2	U <sub>emp.</sub>	U <sub>0,05</sub>
Development of play skills	2.4	1.3	31	34–46

The results demonstrated that pre-school children showed better developed play skills in environments that applied the child-directed approach. The play skills of pre-school children experiencing the teacher-directed approach were less developed.

Analysis of the sociometric structure of the group made it possible to reveal the differences in the manifestation of sympathy and antipathy in both samples (child-directed and teacher-directed approaches). Thus, the number of joint choices differed significantly between the two samples ( $p \leq 0.05$ ). In Sample 1 (127), there were more common choices than in Sample 2 (97).

	Sample 1	Sample 2	U <sub>emp.</sub>	U <sub>0,05</sub>
Number of joint choices	127	97	45.5	47–61

The communication perception of children from Sample 1 was more adequate, and the atmosphere was healthier than in Sample 2. We believe that the child-directed approach facilitates more successful development of the perceptive component of communication with peers.

According to the results, the teacher-child interaction (degree of freedom afforded to children, adult supervision, etc.) is important for the development of communicative and perceptual aspects of child communication with peers. The child-directed interaction allows peer-communication to form more adequately.

## Discussion

Children often take initiative, but are not persistent. The vast majority of the interviewed children did not have issues with choosing partners, which testifies to the well-being of their communication. However, more than half of the children could not think or offer any option of role play or games with rules.

In rare cases, children became involved in conflict. Most children showed constructive ways to resolve conflicts, provide assistance to a peer, and treat him as a partner. Children found it difficult to explain their sympathy. The number of positive choices outweighed the number of negative choices.

Child-led communication benefits the development of play skills and sympathetic peers. This ability can provide a solid basis not only for the development of communicative competence but also for the formation of stable self-esteem, educational initiatives and success at school (Nisskaya, 2013). Additionally, the child-directed approach has no unwanted effects. Child-led communication is a way to facilitate the development of play skills in preschoolers, as well as to develop focus, patience, and so on.

According to the results, the teacher-child interaction (the degree of freedom provided to children under adult supervision, etc.) is essential for the development of communicative and perceptual aspects of communication of children with peers. The interaction of children in peer to peer communication allows for adequate development.

The authors who study the problems of the educational environment (Rubtsov V. V., Slobodchikov V. I., Ulanovskaya I. M., Jasvin V. A., etc.), teacher-child communication as a component of the educational environment (Petrovsky V. A., Rubtsov V. V., Birch, S. H., Downer, J., Sabol, T. J., Hamre, Ladd, G. W., Locasale-Crouch, J., DeCoster, J., & Pianta, R. etc.), and the quality of pre-school educational environments (Shiyan, 2013) agree that adults influence the development of children. Our study clarifies how teacher-directed and child-directed approaches are related to various components of preschoolers' peer-communication, such as sociometric status, success in peer-communication, play skills, proactiveness, and behavior during conflict, and proves the considerable potential of the child-directed approach in child development and education.

## Conclusion

Peer-communication from the ages of four to six years old is at the stage of formation and evolution. Particularly, the sociometric structure of a group is starting to form. For many children, the choice of a partner is an easy task. Children know who they want to choose and who they do not want to communicate with. In most cases, children treat their peers positively. Positive choices surpass negative choices. However, the awareness of these choices is not high. Children experience difficulties in explaining the nature of their sympathies and antipathies.

Most children are successful in peer-communication and have many partners and counterparts to choose from. Play skills and proactiveness are formed insufficiently. Most children cannot master a wide range of games and play skills and prefer a passive or subdued role. Children seldom take part in conflicts. Most of them are able to resolve conflict situations in a constructive manner. Few children demonstrate aggression.

The connection between teacher-directed and child-directed approaches and peer-communication quality has been proven. The child-directed approach meets the specific age needs of children. It is well known that play is the leading activity at the preschool age. Therefore, children who have an opportunity to practice various games, roles and rules achieve a higher level of development of play skills.

It was demonstrated that teacher-directed and child-directed approaches impact the sociometric structure of the group and attraction. The child-directed approach is positively connected with the intensity of common peer sympathies and antipathies. We believe that it occurs because children have the opportunity to play with peers and get to know each other better as well as make decisions on who they like or do not like.

We believe that the conditions under which children do not have to compete in classes provide more positive attitudes among children.

Therefore, the child-directed approach positively impacts the development of children's peer-communication.

This study showed that this approach helps children build harmonious peer-communication in this age group compared with children in kindergarten, who experience the teacher-directed approach. The results indicate that we should continue to facilitate the spread of the child-directed approach, use it in programs for preschoolers, create methodical recommendations for teachers, and assess the quality of preschool education. Additionally, our findings support that teachers should communicate with children more freely, allow them to follow their interests, encourage children's independence and activity, and allow children to spend more time playing.

This study clarified particular practices in child-centered and teacher-centered approaches. It is important to know how various teaching practices affect peer-interaction. Additionally, several additional variables should be evaluated to further this research. For example, it is necessary to control for the influence of family culture, level of development of children's speech, duration of study in preschool, cultural background, and parent-child relationships.

### **Limitations**

We understand that preschoolers' peer-communication is affected not only by preschool conditions but also by their family background, personality, and social environment (cultural, traditional, ethnic, etc.). This research should be continued and involve further investigations.

The above mentioned results could be used for preschool education development, particularly in regard to the teacher-student interaction. Moreover, child-parent relationships can be enriched by supporting child activity and initiative.

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## **Cognitive and value parameters of students' perceptions of the effects of psychoactive substances**

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This article sets forth the main results of a study analyzing attitudes toward psychoactive-substance (PAS) effects. These findings demonstrate the conditionality of social, historic, and cultural views of PAS effects. Despite the threat posed by increasing high school and university students' drug involvement, exploration of this phenomenon in the format of scientific discourse has been limited so far.

In 2014–2015, in Yekaterinburg, Moscow, and Krasnoyarsk a survey to evaluate perceptions of high school and university students about PAS effects was conducted (289 respondents, aged 16–22). The methods used included the semantic differential (Peabody Picture Vocabulary Test modified by A.G. Shmelyov), a modified version of the Rokeach Value Survey, word associations, and content analysis.

The use of psychoactive substances is a specific social practice emerging in a certain social context that includes both drug-addicted and PAS-free young people. Examination of the factors affecting the formation of views about PAS effects and the dynamics of youth values is possible by using a bio-psycho-socio paradigm for performing a complex analysis of cognitive, behavioral, and value parameters.

As documented in the respondents' perceptions, distinctive features that are characteristic of drug addicts and that are seen in their behavior area loss of control over behavior, emotions, and volition; changes in value systems; and a tendency to develop a manipulative communication style.

Within the system of their social perceptions the respondents endowed drug-addicted persons with pronounced negative characteristics ("aggressiveness," "addiction," "stupidity," "light-mindedness"). Still, they stated that drug abusers are capable of being active, decisive, cheerful, generous, and flexible. The value analysis demonstrated that terminal values appreciated by the school and university students included health, true friends, love, happy family life, active life, and self-development. Receiving pleasure through methamphetamine intake and a burst of energy through PAS intake were considered worthless even though the survey demonstrated the respondents' use of psychoactive substances.

**Keywords:** perceptions, value preferences, PAS effects, factor analysis, semantic space

## Introduction

According to experts of the US National Intelligence Council who analyzed the prospective dynamics of global trends, indicators associated with a widespread “insecurity feeling” rank high. A picture of the world’s future with regard to Russian tendencies underlined the finding that Russia faces a “potentially explosive situation due to the spread of AIDS” (Shubin, 2005, p. 13). Such a situation reveals the PAS impact on personality, signifies the close relationships between drug use and HIV/AIDS, and determines the identification of the cognitive and value perceptions of youth about PAS effects.

Before the early 1990s the theme of PAS effects did not exist in academic discourse because information about the drug problem was available only to an inner circle of medical and legal people (Grigirets, 2012, p. 50). At the beginning of the 1990s socioeconomic complexities at the individual and social levels provoked the intense growth of narcomania; yet, there was a possibility for carrying out open sociological research in this field. Despite this possibility, the sociopsychological aspects of PAS use have not yet become a focus of psychological analysis. Perceptions about PAS effects on personality present an aspect of reality in which individual consciousness is objectified. “Technological progress in all spheres of human activity provokes modifications of co-operation, transforms communications and social networks” (Zotova & Zinchenko, 2014, p. 61).

Perceptions embody social dispositions and cognitive determinants of young people’s social behavior and their interpretation of the nature of PAS effects. “The essence of the modern paradigm shift in science is that new objects—complex, self-developing, open systems; their modern status; as well as the main prospects for academic knowledge and technologies—come into researchers’ sight” (Zinchenko & Pervichko, 2012, p. 37).

The examination of PAS effects inherently contains consideration of priorities in the value system of students. The choice between individuals’ curiosity satisfaction or craving for new sensations in spite of the declared threats and risks, on the one hand, and their abandonment of these pursuits on the basis of rationalism and morality, on the other, depends primarily on their value system. Yet, Maio and Olson (1998) showed that respondents quite often make their choices impulsively, intuitively, or traditionally. In this respect, it seems sensible to use supplementary methods for analyzing values, and such an effort was made in this research.

Measures against drug use among Russian youth require reinforcement of sustainably negative attitudes toward narcotics and the formation of a confident belief in their harmful impact on human personality. In order to realize this task it is necessary to identify young people’s views of PAS effects. A theory that might be productive in answering vital questions related to individuals’ attitudes toward narcomania as a social practice and its personality-destructive consequences is social-perceptions theory.

In their research on social perceptions Dontsov and Yemeljanova demonstrated that one of the functions of such perceptions is “to act as a mechanism regulating the behavior of individual and group subjects” (1984, p.150). For any group of

young people a perception about the nature of different PAS effects can be a bearer of value, an incentive, or a negative factor in shaping a certain system of attitudes toward risk or PAS use. Youth social perceptions form content-associated elements of group identity and a shared world outlook and its assessment—in particular, mutual understanding of the acceptability or unacceptability of drugs and their positive or negative connotations; “individual self-expression, subjective partiality, the buildup of oneself, the creation of human life cannot be separated from a way of describing the world” (Zinchenko & Zotova, 2014, p. 53).

Here are the data of a pilot survey conducted by Grebennikova (2010) in Moscow (Moscow State Pedagogical University). In this survey a social-perceptions questionnaire was used to find out the specific views of 100 young people aged 15 to 19. Half the respondents found it difficult to make a choice in a challenging situation and to assume responsibility for their decision. Nevertheless, 90% of the young people pointed out the importance of social environment in shaping personality. Thus, the survey highlighted the significance of group behavior and value bearers (peers, classmates, neighbors, relatives) in shaping views of PAS determinants and effects. It is not surprising that such views of the role of the social environment determined a certain group value in the course of communication interaction and in the world outlook of the respondents. It should be taken into account that “values during communication are implied and transmitted together with other things, but they do not become the subject of communication. They are activated only as premise not as a statement” (Luhmann, 2006, p. 229).

## Method

In 2014–2015, in Yekaterinburg, Moscow, and Krasnoyarsk a survey to evaluate the perceptions of high school and university students about PAS effects was conducted (289 respondents, aged 16–22). The testees were asked to evaluate their own subjective reality in the context of sociopsychological security based on the similarity-contrast principle: psychological security, stability, confidence the subject feels/does not feel. Thirty-two 7-point bipolar scales were used. The adjectives were interrelated in four groups within a 4-polar personality-trait model. According to Shmelyov (2002), the use of this 4-polar model makes it possible to “clear” subjective-judgment results not only of social-desirability artifacts but also, in particular, of descriptive factors (characterological perception in this case) in measuring the emotive, value/attitude component of social settings. The results were interpreted with the help of the Big Five scale of personality traits: Friendliness, Intellect, Activeness, Self-control, and Emotional stability. Interpretative names of the factors correlate with the results of the Russian taxonomic study of personality traits.

The survey was aimed at analyzing perceptions of healthy young people without PAS addiction (that is, those not registered by the Drug Prevention Service). The survey was administered to respondents who had never taken psychoactive substances or had used them just once or twice. When the sample was divided into two subgroups, the Mann-Whitney *U*-test did not reveal any significant differences; we could thus examine all the results holistically.

## Results

The results processed in line with the semantic-differential method (Peabody Picture Vocabulary Test modified by A.G. Shmelyov) showed that the respondents' self-image basically consisted of positive features (90.6% of the descriptions). A dominating scale in self-description was Self-control, which was used to evaluate a person's level of motivation, organization, and persistence in goal-oriented behavior. From the point of view of the leading qualities providing behavior activation and orientation, the respondents' assessments of themselves emphasized selectivity, practicality, and carefulness. Hence, they were aware of the fact that behavior regulation is enabled by reliability and exactingness, ambitions and persistence—characteristics that are due largely to a respondent's age.

Taking into account the fact that people can evaluate and perceive a drug addict differently, the respondents were asked to describe the following images: self-image and image of a drug user. The results were processed via Spearman's rank-correlation coefficient and factor and principal-component analyses, which made it possible to solve the given tasks using SPSS11.0.

The respondents marked the following traits of their self-image: Critical (1.23), Cheerful (1.46), Tactful (1.36), Sincere (1.61), Flexible (1.16), Active (1.45), Generous (1.36), Practical (1.34), Selective (1.41), Cooperative (1.79), Uninhibited (1.18), Intelligent (1.29), Pleasant (1.71). The dominant features of a drug taker singled out by the respondents were: Light-minded (−2.19), Untactful (−1.93), Agitated (−2.29), Impulsive (−2.07), Unpleasant (−2.07), Aggressive (−1.59), Erratic (−1.61), Indiscriminate (−1.75), Addicted (−1.81), Lazy (−1.69), Stupid (−1.88), Cheerful (1.44), Overconfident (−1.44), Slow (−1.44), Brave (1.08). Thus, the respondents' overall image of a drug addict was negative. They saw such a person as being unreliable, inconstant, unprincipled, overly self-confident, aggressively inclined and as having a low intellect and slow reactions. However, they also saw such an individual as brave and joyful. The results obtained allow us to draw the conclusion that self-image is characterized by adequacy, sociability, activeness, and cheerfulness, while a drug taker receives a low estimate on these characteristics.

A dominant negative scale in the image of a drug taker was Emotional instability (−2.29); this scale assessed self-confidence. The scale Intellect (−1.88) also had a negative value, a rating that testified to the young people's low estimate of the intellectual abilities of a person affected by psychoactive substances. The scale Self-control (−1.37) indicated that the respondents considered a drug addict to be a person incapable of balancing emotions and behavior. A similarly negative scale was Friendliness, which indicated that a drug taker was seen to be aggressively inclined and that it was difficult to constantly maintain fellowship with such a person.

The analysis of self-image and the image of a drug taker based on mean point values was further extended by factor analysis. The reason was that the objective was to define not only dominant, hierarchical relations between the characteristics presented and their corresponding allocation according to their significance (vertical slice) but also semantic, content-based links that united them in separate blocks and factors.

The results of factor-analytical processing gave us the opportunity to identify six significant factors describing PAS addicts.

The first factor (12.09% of total variance) involved the following traits:

flexible	.741
combative	.731
soft	.700
active	.630
generous	.526

The content of the first factor makes it possible to interpret it as Flexibility, which is associated with adaptability, easy disposition, and dissipation. It implies that a PAS taker has to be socially flexible because deviant behavior is socially unacceptable.

The second factor, with 10.84% of the total variance, consisted of such qualities as:

selective	.715
critical	.703
careful	.692
well-organized	.571
pleasant	.542

The opposite pole was represented by the following scale:

untrustworthy	-.713
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The content of this factor enables us to treat it as Carefulness, which speaks about suspiciousness, caution, ability to make choices.

The third factor (9.46% of the total variance) was made up of these scales:

brave	.667
confident	.623

The opposite pole embraced the following traits:

overconfident	-.632
pretentious	-.546

The content of this factor makes it possible to interpret it as Confidence. This factor characterizes the high ambitions of a drug taker.

The fourth factor, with 8.59% of the total variance, included the following qualities:

persistent	.779
independent	.764

The content of the fourth factor allows one to treat it as Independence.

The fifth factor (7.71% of the total variance) had these characteristics:

practical	.665
intelligent	.642
hardworking	.622

The content of this factor makes it possible to interpret it as Purposefulness. This factor speaks about readiness to act, ability to make decisions, and orientation to goals including deviant ones.



The sixth factor, accounting for 7.49% of the total variance, involved the following qualities:

peaceful	.748
cooperative	.670
tactful	.523

The content of this factor enables us to treat it as Tactfulness. This factor can imply correctness of conduct and an aspiration to not cause negative public reactions.

The respondents' semantic field built up by the two leading factors, Flexibility and Carefulness, set the respondents' perceptions about a drug user (see Figure 1). The positive semantic space includes the characteristics combative-passive, flexible-rigid, active-inert, soft-rough, sincere-hypocritical, confident-unconfident, principled-adaptive, joyful-sullen, as well as mean-generous, slow-uninhibited. These traits in combination give us the image of a person capable of adapting to the environment and acting decisively and energetically in different situations. Such a person is generous and has easy manners. The opposite part of the semantic field includes the features mild-firm, modest-pretentious, dependent-independent, tactless-tactful, stupid-intelligent, lazy-hardworking, agitated-calm, light-minded-serious. On the basis of these pronounced characteristics the image of a drug taker is of someone who is weak, not clever, and without initiative, with light-mindedness completing the picture.

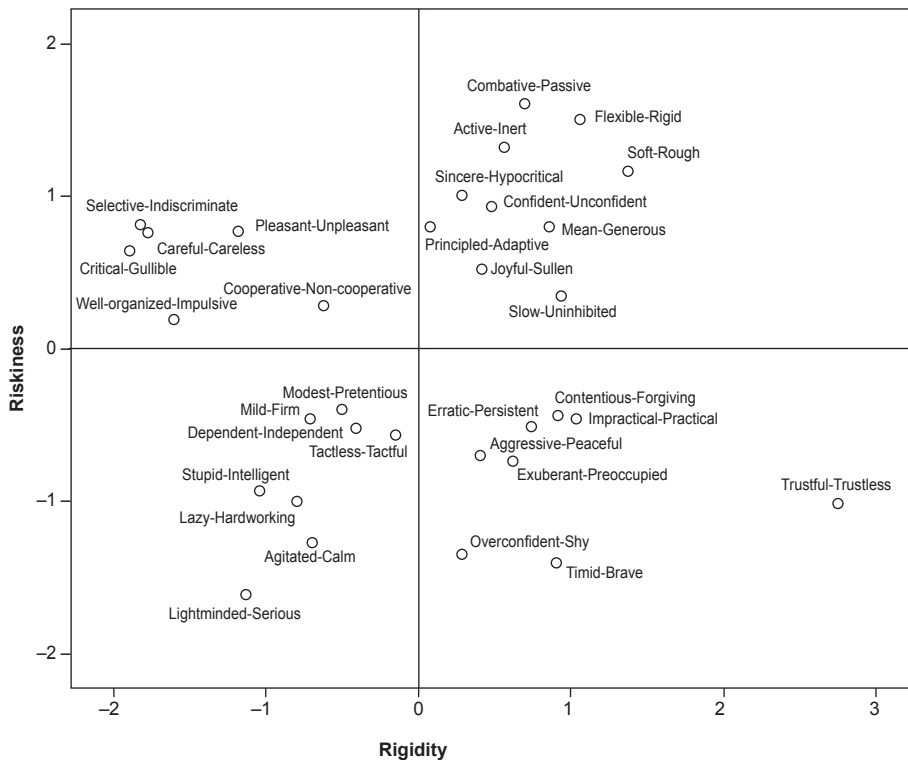


Figure 1. Semantic field of "an image of a drug taker"

Study of the processes involved in the formation of social perceptions about drug effects can become an important instrument for overcoming the destructive influence of the “narco”-culture mythology that exists among teenagers and for developing critical attitudes toward drugs and an objective assessment of PAS effects.

In its anti-narcotics manual the American Drug Policy Alliance considers early intervention as one of its strategic areas when clinically significant levels of drug abuse or addiction are registered. In order to achieve this intervention, it is necessary to define this level for every teenager from 12 to 17.

Recent prevalence estimates indicate that each year more than 1.7 million youths aged 12 to 17 exhibit levels of substance use consistent with the DSM-IV diagnostic criteria for either abuse or dependence. Once adolescent substance use rises to clinically significant levels, such use is unlikely to naturally subside over time and will typically carry over into adulthood. Therefore, early intervention is critical to prevent or minimize the host of social and personal harms that stem from advanced levels of dependence (*An Exit Strategy*. . . , 2013, p. 41).

Nowadays new psychoactive substances constantly appear and become consumer goods for young people. In this situation the importance of perception research involving both drug users and drug-free students becomes all the greater.

The student milieu shapes a nuanced communication system and the discourse of particular young people with regard to the PAS impact on personality. The subjects of this communicative practice, which influences social behavior, are not only drug takers but also young people who possess only theoretical knowledge about PAS nature and effects. The study of youth values, beliefs, choices, and attitudes can contribute to formulation of measures that will prevent young people from being involved with drug-addict groups and that will create the basis for antidrug transformations of social behavior. Youth social perceptions about PAS effects revealed in the course of surveys and empirical research are determined largely by norm-value factors intrinsic to social groups and systems. In his works Doise (1994) showed that initial anchoring is connected with the semantic orientation of the PAS problem and its correlation with social behavior patterns existing in the youth environment.

One of the reasons [for drug addiction] is the aspirations of community members for keeping up [a] reputation within “their” circle, i.e., a desire to suit a certain normative model and perpetual efforts to ensure this suitability. By keeping up reputation an individual keeps up and translates a cultural model (Zinchenko & PereLygina, 2013, p. 109).

In order to specify the results a modified Rokeach Value Survey was applied (Table 1). Terminal values preferred by the respondents included health (physical and mental); true friends; love (affinity and intimacy); happy family life. The least important values were a burst of energy and confidence through PAS intake, pleasure through methamphetamine intake, and the happiness of others (well-being, development and advancement of other people, the nation, and humankind as a

whole). Thus the respondents appreciated close interpersonal relations, which added to their emotional well-being. Positive consequences resulting from drug intake and other people's successes were insignificant.

**Table 1.** The respondents' values

Terminal values	Rank	Instrumental values	Rank
Health (physical and mental)	1	Politeness (good manners)	1
True and close friends	2.5	Cheerfulness (sense of humor)	2
Love (affinity and intimacy with a beloved)	2.5	Orderliness (neatness), ability to keep things and business affairs in order	4
Happy family life	4	Good education (breadth of knowledge, high culture)	4
Active life (abundant life full of emotions)	5.5	Responsibility (sense of duty, ability to keep promises)	4
Growth (self-development, constant physical and mental perfection)	5.5	Independence (ability to act decisively and independently)	7
Wisdom (mature judgments and common sense learned from life experience)	8.5	Self-control (self-discipline, restraint)	7
Good job	8.5	Honesty (truthfulness, sincerity)	7
Prosperous life (absence of financial problems)	8.5	Can-do attitude (discipline)	10.5
Cognition (opportunity to broaden world outlook, get extra education, take culture and intellect to a new level)	8.5	Rationalism (ability to think straight and logically, take well-conceived, rational decisions)	10.5
Freedom (self-sufficiency, independent judgments and actions)	11.5	Strong will (ability to get one's own way, do not give up)	10.5
Confidence (inner harmony, freedom from inner conflicts and doubts)	11.5	Tolerance (to other people views and opinions, ability to forgive others' fault and delusion)	10.5
Public recognition (respected by the people around, team, associates)	14	Courage to stand up for one's opinion, point of view	14
Productive life (maximum realization of one's potential, strengths, and abilities)	14	Open-mindedness (ability to understand others' stand, respect for others' tastes, customs, habits)	14
Entertainments (pleasant, care-free pastimes; lack of responsibility)	14	Sensitivity (attention to people)	14
Creativity (ability to create)	16	High aspirations (high life claims)	16
Beauty of nature and art (ability to experience beauty in nature and in art)	17.5	Efficiency (diligence, productivity)	17
Happiness of others (well-being, growth, and success of other people, the nation, humankind on the whole)	17.5	Uncompromising attitude to one's own and others' faults	18
Pleasure through methamphetamine intake	19	Strong emotions (even with the help of PAS)	19
Burst of energy and confidence through PAS intake	20	Gain of satisfaction and confidence (with dopamine stimulation if needed)	20

Among instrumental values our respondents chose, for example, politeness, cheerfulness, orderliness in life and business affairs, good education, and responsibility. Insignificant values included gaining satisfaction and confidence (with dopamine stimulation if needed); strong emotions (even with the help of PAS); unpromising attitude to one's own and others' faults. Thus, one can assume that when achieving their goals the respondents were guided by their personal discipline and positive thinking. They did not need strong emotions stimulated by PAS intake and struggling against other people's faults.

A survey based on social-perception theory showed how drug use transforms social perceptions about narcotics themselves (Bovina, Dvoryanchikov, Konoplyova, Kobalyov, & Konkin, 2012). In particular, such experience had a dual effect on drug social perceptions: on the one hand, the respondents who used drugs evaluated them in a more positive manner than those who had not used them; on the other, they widened the notion of *narcotic*, adding strong alcoholic drinks to it. Therefore, one can speak of social-perception differentiation intrinsic to drug users and drug-free people.

Let us turn our attention to how important the formation of PAS-effect perceptions is. The parameters of cognitive and value perceptions reveal their significance theoretically as well as practically. Here we can speak about the deficit of teenagers' knowledge about essential PAS characteristics, the after-effects of their use, the biochemical process in the body upon PAS intake, and the prospects of a personality metamorphosis of drug takers. Peirce (2000) gave a detailed explanation of the multilevel nature of cognition processes:

Understanding of a word or a formula can be achieved either through, in the first place, such an awareness of it that might allow one to use it correctly; or, second, through abstract analysis of the notion or understanding of how it intellectually relates to other notions; or, third, through knowledge of phenomenal or practical results of this notion affirmation (Pierce, 2000, p. 225).

The survey context draws attention to the fact that social perceptions perform comprehensive functions: defensive, communicative, affecting an individual's behavior orientation, legitimizing corresponding social relations, and constructive—directed to the formation of the social identity of the communication-interaction subject. Also, depending on the sociocultural context a leading role is fulfilled by these functions, and “social perceptions elaborated by a social group and clothed in specific words and terms are embedded and circulating in society's ‘identification matrix,’ i.e., in a certain system of meanings set by the culture” (Zotova & Solodukhina, 2013, pp. 80–81).

Contemporary research has a tendency toward comprehensive analysis when examining the problem of PAS effects on personality in terms of a bio-psycho-socio paradigm. Considering PAS effects through a set of behavioral, cognitive, value, emotional, and physiological parameters provides the opportunity to observe the distortion of cognitive ability and volition and the alteration of sociocultural orientations, consciousness, and self-awareness (N.F. Fleming, S.V. Dvoruak, T.A. Donskikh, N.V. Dmitrieva, I.B. Bovina, I.B. Yurevich, L.G. Leonova, L.A. Tsvetkova, N.V. Dvoryanchikov, and others).

Among reasons for the great vulnerability of youth is self-concept instability. Thus, some of its specific features can act as a drug-addiction factor. It is common knowledge that self-concept is shaped under the influence of the social environment and that it predetermines a young person's interaction with it. Consequently, the more unstable social factors are, the less stable self-concept appears to be. Another important aspect of the self-concept of youth is body image. Change and development of their bodies never stops, and the same happens to their self-concept, together with ways of interacting with the environment. Proneness to crises and conflicts is also explained by the fact that young people experience not only the need to join certain social groups but also, at the same, the need to separate themselves from their habitual environment and even to confront it in order to attain and to unleash the individual self. It is obvious that self-perception is a powerful phenomenon; it requires continual self-expression and discharge, but, simultaneously, it is indefinite, filled with the experiences of other people: parents, older friends, and other reputable people. This contradiction between potential ability and the real substance of activity generates inner tension, whose release becomes urgent and vital. In young people's opinion the most effective way to defuse tension is often through some form of deviant behavior, including drug-taking (Raigorodsky, 1996).

The study of social perceptions can be useful for understanding the dynamics of human/world relationships, especially with regard to health (Foster, 2003; Howarth, Foster, & Dorrer, 2004). Although it seems natural to examine constructs that respondents use to describe drug use, only a small number of research papers in this area can be found: tobacco-use perceptions (Echabe, Guede, & Castro, 1994; Stjerna, Lauritzen, & Tillgren, 2004), perceptions about drug or alcohol abuse among particular groups of the population (DaSilva & Padilha, 2011), parents whose children are drug takers (Nuño-Gutiérrez, Álvarez-Nemegyei, & Rodríguez-Cerda, 2008), students (Cabral, Da Cruz Farate, & Duarte, 2007), teachers (Martini & Furegato, 2008), heavy drinkers (Alvarez, 2004; daSilva & deSouza, 2005). A paper by Demers, Kishchuk, Bourgault, & Bisson (1996) is of special interest. They considered relationships between strong alcohol use and eight social perceptions. They argue that perceptions should be examined independently of social context and the respondents' life experience. The significance of the phenomenal characteristics of notions in their functioning and interaction is emphasized in the framework of discursive psychology. For students' perceptions, individual mental operations aimed at gaining and processing information about PAS effects on personality equal in importance the social construction of their actions, attitudes, interactions, and identity (Potter, 1996; Wetherell, 1996).

With the aim of deepening our study, we used the free-association method. It resulted in 1,282 associations to the notion *psychoactive substances*; these average, 4.4 associations per testee. Content analysis of the associations included in the core and periphery of PAS perceptions was conducted. The data obtained are as follows: substances (pep pills, narcotics, alcohol) — 37.01%, situation of substance intake (music, club) — 17.41%, effects upon intake (energy, efficiency) — 22.4%. Therefore, in a restructured variant all the categories made up 76.82%.

In the course of the empirical study 1,096 associations were stated in response to the word *narcotics*, which on average is 3.8 elements per subject. A conceptual dictionary contains 189 different words and word combinations for *narcotics*. In

the study, 642 associations entered the core and periphery zones of perceptions about drugs (58.58% of the total associations produced by the respondents).

**Table 2.** The structure of drug perceptions

Structural elements	Notions/associations (frequency; average rank)
Core zone of social perception	Addiction (158;2.17) Disease (139;2.16) Harm (127;2.29)
Zone of potential perception alteration	Syringe (44;2.69) Destruction (41;2.78) Death (26;2.89) Problems (20;2.99) Money (19;3.01)
Periphery perception system itself	Loneliness (25;3.16) Crime (23;3.34) Heroin (20;3.69)

As can be seen in Table 2 the core-zone elements are specified by the periphery elements: on the one hand, the core-zone elements indicate the physical consequences of drug intake: “addiction,” “disease” (the core zone), “destruction,” “death” (the periphery system); on the other, they point out the social effects of drug intake: “problems,” “loneliness,” “crime” (the periphery system). Thus, differences existed in PAS and drug perceptions: PAS effects do not convey a pronounced negative evaluation. In addition, the content of the perceptions included means of drug use: “syringe,” “money,” “heroin.” Here we also observe an essential difference in the PAS and drug perceptions: whereas psychoactive substances were associated with smoking and ingesting pep pills, narcotics were associated with intravenous injections (“syringe,” “heroin”). The notions in the core bear strictly negative emotional coloring (“addiction,” “disease,” “harm”). In addition, narcotics perceptions lack categories describing situations of their intake, while PAS perceptions give a clear picture of this aspect. We can thus conclude that psychoactive substances and their intake were more pronounced in the youths’ practical experience in comparison with narcotics.

In addition, the elements in the drug-perception core zone coincide with narcomania perception elements indicated in Beresina’s survey (2011) as well as in the survey by Bovina and her colleagues data (2012). We can conclude that there is evidence of object-perception equality, and, hence, stability, sustainability, and a high degree of consistency in youths’ perceptions of narcotics.

Comparison of the content and structure of the perceptions show that the youths’ perceptions of psychoactive substances were less consistent and homogeneous than their drug perceptions. Such data as the numerical dominance of notions expressed in response to the stated word combination *psychoactive substances* over the number of entries in a conceptual dictionary (290 and 189 correspondingly) confirm this conclusion. Besides, the frequency of associations entering the core of drug perceptions was a lot higher than the frequency of core components in PAS perceptions. Thus, for instance, the notion *narcotics* (the most numerous in



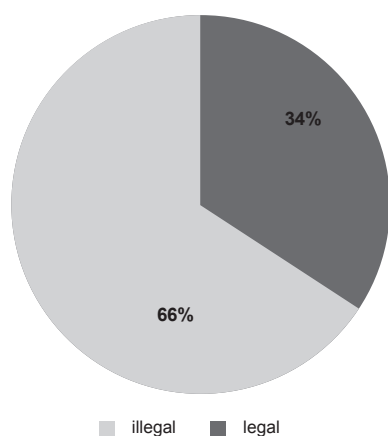
the core structure of PAS perceptions) was stated by just 29% of the respondents, while the notion *addiction* (the most numerous in the core structure of narcotics perceptions) was given by 59% of the respondents. Finally, the core of the drug presentations contained 66% of the total associations entering its structure. In the case of PAS perceptions this indicator accounted for just 41%.

To make our prototypical analysis more precise, content analysis was carried out including all the answers of the respondents. As a result of restructuring materials the following data were obtained: means ("syringe," "heroin") — 11.9%, physical effects ("death," "disease") — 28.25%, social consequences ("loneliness," "problems") — 22.31%. In a restructured variant all the categories made up 62.46%.

Therefore, drug perceptions in the youths' consciousness were mainly specified by the negative effects of their use, both physical and social (50.56%). At the same time the negative character of PAS effects was represented in the youths' perceptions to a smaller degree (22.40%). This difference can be explained by an intense media campaign aimed at building awareness of negative drug-intake effects, while PAS effects were given considerably less attention. Thus, the young people possessed limited knowledge about the harm caused by psychoactive substances. "The lack of security takes the lead, starts to determine motive rebuilding, rearranging this motivation and specifically transforming other groups of basic needs, psychic characteristics and personal traits" (Dontsov & Zotova, 2013, p. 81).

However, for the substances themselves (narcotic or psychoactive) a reverse tendency can be observed. Narcotic means were much less well represented in the youths' consciousness than psychoactive substances (11.9% and 37.01%, correspondingly). One probable explanation is the greater availability (real or potential) of PAS for young people.

Further analysis involved categorization of psychoactive substances. All associations mentioned were divided into groups of psychoactive substances regarded as legal and illegal under Russian Federation legislation (Figure 2).



**Figure 2.** The proportion of legal and illegal substances (under Russian Federation law) in the structure of youths' perceptions about PAS

The group of illegal means contained substances whose free circulation is forbidden and regulated by the state as well as those means distribution of which is restricted and which are subject to state control according to Russian Federation legislation and international agreements.

The subjects did not mention such psychoactive substances as tea and coffee, which are consumed on a regular basis. In the youths' perceptions the most common legal psychoactive substances were cigarettes, alcohol, and energy shots. Still, the share of legal substances was much smaller compared with illegal ones, whereas perceptions about their aftereffects in comparison with the aftereffects of narcotics were insignificant. To put it differently, young people in their consciousness mainly relate narcotics to psychoactive substances, but they remain unaware of the aftereffects of their use when classifying them as psychoactive substances. In other words, the cognitive parameters of high school and university students' perceptions about PAS effects were vague, and the correlation of drug intake and the distortion of personal characteristics was realized and considered to a dramatically limited extent. As has been observed, value parameters "will be partly defined by the situation specifics, by the way the question is asked and by whom it is put; it will depend on how well-shaped an individual's perception of his own value system is" (Podolsky, 2012, p. 363).

## Conclusion

In the context of a bio-psycho-socio paradigm the study demonstrated that insufficiently formed school and university students' perceptions about their own value attitudes and the instability of their self-concept determined their negative perceptions of narcotic effects alongside their tolerant perceptions of PAS effects. In the study the combination of cognitive and value parameters indicated a vector of the change in behavior patterns through considerable representation of psychoactive substances in the practical experience of youth.

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## **Pilot research on a pupil's psychological safety in the multicultural educational environment**

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In the modern world, the environment of any educational institution represents a spectrum of ethnic groups and subcultures: a multicultural educational environment. Pupils who are aware of their national identity often demonstrate intolerance toward students of other nationalities, which threatens pupils' psychological safety. In this article, we present the results of pilot research examining the level of a pupil's psychological safety in the multicultural educational environment and identifying the criteria that influence a pupil's psychological safety. The research sample comprised 127 pupils aged 13–14 years from different schools living in various places that differed by the type of settlement, industrial development and level of science and culture. We isolated the following criteria for a pupil's psychological safety in the multicultural educational environment: satisfaction with the educational environment, protection from psychological abuse and self-confidence. According to pupils, the essential characteristics of safety in the educational environment, regardless of school category and type, are being able to ask for help, protection of personal dignity, interactions with other students, and self-respect.

Empirical data reveal the current status of the psychological safety of the entire sample group ( $n = 127$ ) and compare indices of psychological safety in the educational institutions under study.

Analysis of the results of our research indicates that protecting a pupil's personality in the multicultural educational environment has the greatest influence on his/her psychological safety. In addition, a comfortable psychological atmosphere, mutual aid and support of pupils and low levels of classmates' and coevals' aggression positively influence the protection experience.

**Key words:** multicultural education, educational environment, psychological safety

### **Introduction**

The problem of multicultural education in modern Russia has become more significant during the last decade with the increase in forced migration, refugees and labor migrants. Development of multicultural education is a current issue for “most

Russian territorial units – republics, territories and regions, for cities and towns and rural settlements. The problem of the multicultural approach is also relevant for Tula Region. According to Regional Statistics Service data, migration in Tula Region has been positive in nature since 2005” (Kulikova, 2015, p. 831). Since 2014, the flow of refugees from Ukraine has increased. Tula Region has welcomed more than five thousand newly arrived immigrants who were given accommodations and work in the regional center, and their children have been able to study in Tula schools. Certainly, representatives of different nationalities, other cultures and other traditions were among the refugees’ children.

Despite the reason, forced migration always leads to changes in the normal pattern of life and the social status of families, the appearance and demonstration of school socialization among refugees’ children, and tension among nationalities in the group of coevals. All of these changes are accompanied by emotional experiences and mental disturbance. One of the primary conditions of good health and children’s psychological well-being is their experience with psychological safety.

Feeling safe enhances a pupil’s mental health, which allows students to assimilate material well and develops his/her mental and psychological characteristics and properties according to that pupil’s personal characteristics. Feeling safe enhances appropriate attitudes toward problems and difficulties, eliminates the fear of independence and contributes to a child’s physical and mental health. A child who fears school, a teacher or classmates, who is not protected from psychological abuse, is not able to study well and develop normally.

The problem of psychological safety in the educational environment and as a component of the educational process has been actively developing in Russian psychology. Psychological safety in the educational environment has developed theoretically and in application because of the works of V.V. Rubtsov, I.A. Baeva, E.N. Volkova, A.M. Konstantinov, V.A. Yasvin and others. These researchers have shown that an important factor in developing character in the educational environment is safety. Criteria of psychological safety in schools have been developed, and levels of protection of schoolchildren from threats and abuse have been described. Despite these advances, we have not established a sufficient and exact understanding of a pupil’s psychological safety in the context of multicultural education.

Ideas regarding the necessity of a child’s personality development in a multicultural environment are presented in the pedagogical works of Jan Amos Komensky, J. Pestalozzi, P.F. Kapterev, V.A. Sukhomlinsky, K.D. Ushinsky and others. For example, Komensky created a project of social and cultural changes and the built-in school model. In school programs, special attention is paid to the importance of developing the ability to respond to mutual responsibilities, the skill to live in peace with others and to respect and love those people close to children (Bessarabova, 2007). P.F. Kapterev emphasized that we should apply “not to a single nation but to many” in identifying and enlarging the “drawbacks of your own national ideal... with others’ valuable features” (Kolobova, 2005, pp. 105-114). K.D. Ushinsky’s concept of a child’s personality is based on the principle of integrity, which suggests not only a system of knowledge but also generates moral values, a deep understanding of the meaning of life, relationships between people, realizing one’s own place, and the desire and ability to bring harmony and love to the world (Shevchuk, 2001).



We also observe the issue of the multicultural educational environment in the works of foreign researchers (J. Banks, C. Grant, S. Nieto). According to J. Banks (1996), the process of multicultural education is reflected in five primary functions of a teacher: "integration of contents, the process of knowledge construction, overcoming prejudices, fair pedagogy, development of school culture and social structure" (p. 188). K. Grant (2008) presented the history, the origin and stages of the transformation of multicultural education in the USA.

S. Nieto (2004) observed that the educational environment includes a collection of conditions in which we can see human formation, development and education; and the multicultural environment also provides mutual cultural enrichment in all subjects of the educational process.

In studies on the educational environment, Western researchers accentuate studying the school climate (R. Moos, H. Fend, U. Bronfenbrenner), and the topic of social relations dominates these studies. According to Moos (1979), the construct of "social climate" includes the environment that is subjectively experienced by an individual in certain behavior patterns. The importance of studying schools and the class climate as a subjective component of the educational environment was also emphasized by Fend (1977); in his opinion, an individual "can resist bad material circumstances much easier than human environment, which humiliates or suppresses him" (pp. 9-32). Bronfenbrenner (1979) also believed that psychological components of the environment manage an individual's behavior to a greater extent than "objective" (physical) environmental properties.

Foreign psychologists have conducted studies on the psychological comprehension of safety problems: creating schools that are safe for pupils' emotional health, reforming secondary school to increase school safety, and school abuse research (Bluestein, 2001; Brand, 2003).

Summarizing the research of Western scientists, we can conclude that despite the variety of approaches, most authors focus on the relationship between teachers and students and relationships among students as components of the educational environment that influence the psychological climate.

Traditionally, Russian psychology examined a personality in its interconnection with the social environment. L.S. Vygotsky's ideas (1984) were significant in substantiating this thesis. That scientist justly noted that the primary drawback to such research is to study the environment with the help of its absolute indices without reference to a child, and Vygotsky noted that the environment that is identical in terms of absolute indices is completely different for children of different ages. As a unit of environmental study, L.S. Vygotsky cited experience as a unity of the personality and the environment, represented in its development as the "inner attitude of a child as a person to this or that moment of reality" as an indicator of the influence of a particular moment of reality on a child's development. L.S. Vygotsky mentioned that "the environment determines a child's development through environment experience" and appealed for study of the environment to be transferred "to a greater extent inside the child" (pp. 31-32) instead of the external conditions of his/her life.

According to S.L. Rubinstein (2003/1957), a human's entire course of life is defined by the system of his/her basic life relations: to himself/herself, another person and the world as a whole. A person begins his interaction with the [multicultural]

world, first, as part of the world, and then as one who perceives being able to transform that world.

The outstanding Soviet psychologist A.N. Leontiev (1998/1973), addressing the problem of social and mental conditionality, noted that during the process of his individual development, a person inevitably enters into “special, specific relationships with the surrounding world of things and phenomena which are created by former generations of people” (pp. 108-119). A person’s circle of first-hand contacts is “the nearest social environment” or “a social group” that influences the individual in various manners.

According to V.A. Yasvin (2001), the quality of the educational environment is defined by its ability to satisfy the primary needs of the age, for example, needs for safety, recognition, acceptance, respect, social approval, love, and preserving and bolstering self-esteem. N.I. Polivanova and I.V. Ermakova (2000) noted that the educational environment is realized in the teacher’s and children’s academic work and in their interactions during a lesson or between lessons; they also noted that the educational environment is an important factor in pupils’ effective mental development.

## Method

Realizing that the quality of the educational environment in a modern school does not always contribute to children’s psychological safety, we conducted pilot research to define the level of a pupil’s psychological safety in the multicultural educational environment and to reveal the criteria that influence a student’s psychological safety. The sample comprised 127 pupils from 7<sup>th</sup> and 8<sup>th</sup> forms, aged 13-14 years, from different schools. The students also lived in places that varied in the type of settlement, degree of development of industrial production and condition of science and culture. We chose Tula (a regional center), Shchyokino (a district center) and the village of Anishino, Venyov District, Tula Region, as the environments. To present the results in a more convenient manner, we labeled the schools (sub-samples) that participated in the experiment in the following manner: “1M” (Tula Municipal School), “2D” (Shchyokino District School) and “3R” (Venyov District Rural School). All of the schools that participated in the experiment were multicultural and multinational. The pupils of non-indigenous nationality in these schools numbered 35%-65%. All of the pupils lived with their families in the areas in which the schools were situated, and the parents were Russian citizens. The highest percentage of refugee children was in the Venyov District Rural School (subsample “3R”).

The homogeneity of the experimental groups was defined using Student’s *t*-test. The received empirical value  $t=0.3$  was in the insignificance zone ( $p \leq 0.05$ ;  $p \leq 0.01$ ); therefore, there are no grounds to state the heterogeneity of independent samples. The statistical significance of differences in the experimental distribution was one and the same feature was defined according to  $\chi^2$  – Pearson test ( $p \leq 0.05$ ;  $p \leq 0.01$ ). Mathematical data treatment was conducted on the basis of the modern statistical analysis package Statistica 6. Obtained empirical data revealed the current status of psychological safety of the entire sample group ( $n=127$ ) and compared indices of psychological safety in the educational institutions under study.

Based on the analysis of research on a person's psychological safety (I.A. Baeva, E.N. Volkova, E.B. Laktionova, 2009), we singled out the following primary criteria of a pupil's psychological safety in the multicultural educational environment:

- 1) **Satisfaction** is displayed in experiences of subjective well-being, emotionally positive attitudes from teachers and classmates, satisfaction with one's own academic activity and corresponding behavioral manifestations.
- 2) **Protection** is displayed in experiences of support from teachers, support from parents and affection from classmates in addition to the absence of aggressive behavioral manifestations.
- 3) **Self-confidence** is displayed in the peculiarities of school anxiety and self-confidence in difficult situations of learning activities and communication in addition to accepting one's own ethnic identity.

To study the chosen criteria of a pupil's psychological safety, we used a specially designed system of diagnostic methods (Table 1).

**Table 1.** System of psychodiagnostic methods

Criterion	Methods
<i>Satisfaction</i>	<ol style="list-style-type: none"> <li>1. The questionnaire "Psychological Safety of the Educational Environment" by I.A. Baeva</li> <li>2. Evaluation methods of class atmosphere attractiveness by A.A. Rean</li> </ol>
<i>Protection</i>	<ol style="list-style-type: none"> <li>1. The questionnaire "Psychological Safety of the Educational Environment" by I.A. Baeva</li> <li>2. Multifactorial scale of coevals' victimization by I.A. Furmanov</li> </ol>
<i>Self-confidence</i>	<ol style="list-style-type: none"> <li>1. Methods of diagnostics of school anxiety level by Fillips</li> <li>2. Methods of evaluation of ethnic identity types (G.U. Soldatova, S.V. Ryzhova)</li> </ol>

The questionnaire "Psychological Safety of the Educational Environment" by I.A. Baeva comprises three parts: 1) attitude toward the school educational environment, 2) significant characteristics of the school educational environment and satisfaction with those characteristics, and 3) protection from psychological abuse during interaction. Therefore, the results of this questionnaire indicate the criteria of pupils' attitudes toward the school's educational environment and define the levels of satisfaction and protection as components of the psychological safety of the educational environment (I.A. Baeva, E.N. Volkova, E.B. Laktionova, 2009).

Evaluation methods of class team attractiveness by A.A. Rean define the level of psychological well-being and comfort and in conjunction with other methods, present a more comprehensive picture of a pupil's psychological safety in the educational environment.

The multifactorial scale of coevals' victimization by I.A. Furmanov measures the level of aggression and suggests acquiring information regarding the frequency of direct forms of physical, verbal and social aggression.

Methods of diagnosing school anxiety level by Fillips show the level of a pupil's confidence in various situations of learning activity and communication. In

our research, we defined the following significant factors that characterize a pupil's psychological safety: common school anxiety, experiences of social stress and fear of self-expression.

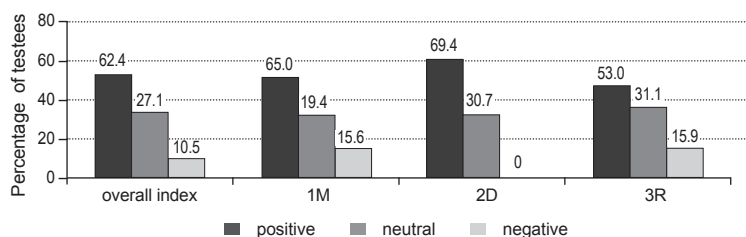
Methods of evaluation of ethnic identity types (G.U. Soldatova, S.V. Ryzhova) enable the diagnosis of ethnic self-awareness and its transformation under the conditions of interethnic intensity. We focused particularly on two factors: ethno-egoism and ethno-isolationism.

These methods identify experiences of psychological support from teachers and classmates (protection), experiences of positive emotional attitudes from teachers and classmates (satisfaction), and experiences of school anxiety and acceptance of one's own ethnic identity (confidence).

## Results

The experimental data according to the questionnaire "Psychological Safety of the Educational Environment" by I.A. Baeva produced various results. Because of the peculiarities of the questionnaire composition, we provide the results from each component.

The first portion of the questionnaire reveals pupils' attitudes toward the school educational environment. The distribution of pupils according to three types of attitude (positive, neutral and negative) toward the school educational environment is presented in Figure 1.



**Figure 1.** Distribution of the student participants according to the index of attitude toward the school educational environment

The best situation is observed in subsample "2D". The index "negative attitude" was not identified in this group of pupils. A positive attitude toward the educational environment was reported by 69.3% of the pupils, and a neutral attitude was reported by 30.7% of the pupils. The pupils in the subsample "1M" demonstrated quite a good attitude toward their educational environment. The number of pupils with the index "positive attitude" was 65.0%, which is nearly twice as many as the number of respondents with neutral (19.4%) and negative attitudes (15.6%). In the third subsample, "3R", 15.9% of the pupils clearly stated their negative attitude toward their school. The number of students in the study with the index "positive attitude" was 53.0%, and the neutral attitude was conveyed by 31.1% of the respondents. In most cases (63.6%), the pupils assessed the mood of the school positively, and 79.5% of the pupils scored their school by the criteria "I don't like — I like" from 7 to 9 points on a scale of 1–9. This attitude may be a result of this being

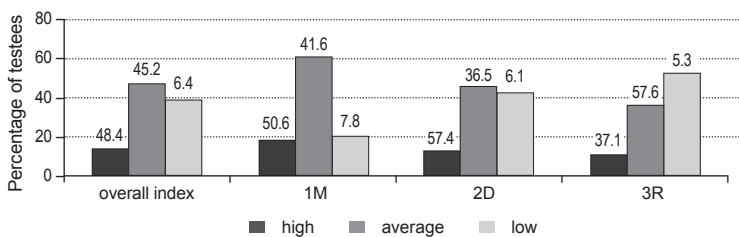
the only available school for the pupils in the village and neighboring settlements; therefore, the children do not see the possibility of choosing another school.

When defining more significant characteristics of the educational environment and the level of pupils' satisfaction with these characteristics, we focused on the following indices of the second portion of the questionnaire:

- relationships with teachers
- relationships with pupils
- the ability to express one's own point of view
- respect for himself/herself
- preservation of personal dignity
- being able to ask for assistance
- possibility of taking initiative, zeal
- considering personal problems and difficulties

Significant characteristics of the educational environment were evaluated according to a five-point scoring system. Correlation of the data regarding characteristics of the educational environment provides insight into such significant characteristics as the possibility of asking for assistance, preservation of personal dignity, relationships with other students, and respect for oneself.

Significant characteristics for the pupils in subsample "1M" are being able to ask for assistance (4.1 points), relationships with other students (3.9 points), preservation of personal dignity (3.9 points), respect for himself/herself (3.5 points), and considering personal problems and difficulties (3.4 points). The students in subsample "2D" attach special significance to the preservation of personal dignity (4.1 points), the being able to ask for assistance (4.1 points), respect for himself/herself (3.6 points), the possibility of taking initiative, and zeal (3.5 points). Significant characteristics for subsample "3R" are relationships with other students (4.3 points), being able to ask for assistance (4.2 points), the preservation of personal dignity (4.1 points), relationships with teachers, and respect for himself/herself (3.5 points).



**Figure 2.** Distribution of the pupils under study according to their levels of satisfaction with all characteristics of the school educational environment

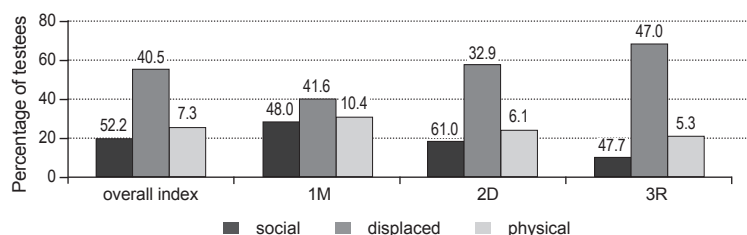
Analyzing the distribution of the pupils in this study by levels of satisfaction with the educational environment (Figure 2), we observe a high level of satisfaction in subsample "2D" (57.4%), which exceeds the overall index (48.4%) whereas only 37.1% of the pupils expressed a high level of satisfaction in subsample "3R". The

reason for the decline in their level of satisfaction with the educational environment may be pupils' unmet needs for emotionally positive relationships with peers, feeling unable to ask for assistance and believing that their personal dignity has been violated.

The third portion of the questionnaire presents particular and overall indices of the level of protection from psychological abuse in the educational environment. I.A. Baeva suggested the following directions for this purpose:

- protection from humiliation/insults
- protection from threats
- protection from compulsion
- protection from social isolation
- protection from unkind attitudes

Evaluating the level of protection from psychological abuse was conducted according to a five-point system. Correlating estimates of levels of protection from psychological abuse indicated that all of the students in the study were primarily protected in the index of protection from social isolation (3.5 and 3.6 points). In addition, students in subsample "2D" reported a high level of protection from threats (3.4 points), and students in subsample "3R" reported a high level of protection from humiliation/insults (3.5 points).



**Figure 3.** Distribution of the pupils in the study by levels of protection from psychological abuse in cooperation

Analyzing the distribution of the students according to levels of protection (Figure 3) indicates that the students in subsample "1M" have deeper feelings of vulnerability in the educational environment. Experiencing high levels of psychological protection is typical only in 48.0% of the pupils, which is slightly lower than the overall index of the same level (52.2%). A greater number of the students (10.4%) in this subsample were psychologically abused.

Examining class environment attractiveness according to A.A. Rean's methods enhances the conception of a pupil's psychological safety in the educational environment. Classifying students according to grade point average was key to interpreting class team attractiveness. The highest degree of class team attractiveness was in subsample "2D" (67.1%), the only group with no negative assessments.

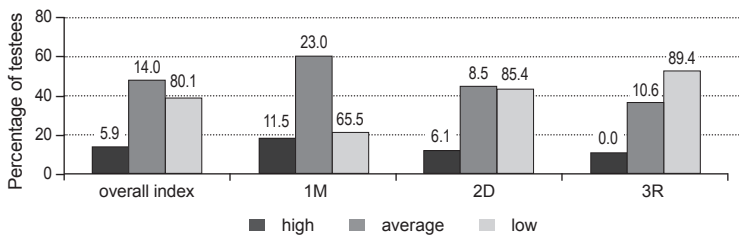
In subsamples "1M" and "3R," 52.0% and 47.7% of students described the atmosphere of their classroom as comfortable and favorable, respectively. An approximately equal number of pupils (15.6% and 15.9%) gave a neutral assessment



to their class atmosphere in the same groups. A neutral attitude toward the class atmosphere is evidence of the presence of certain uncomfortable relationships that influence a pupil's perception of her/his own position in the class.

To identify more possible uncomfortable experiences in the group of coevals and to present a more comprehensive view of psychological protection, we used the multifactorial scale of coevals' victimization by I.A. Furmanov. This method measures levels of aggression and suggests acquiring information regarding the frequency of direct forms of physical, verbal and social aggression.

Distribution of the students according to the index of total victimization (Picture 4) was performed on three levels (low, moderate and high). The overall index indicates that most pupils (80.1%) are not victims of aggressive actions from their classmates or coevals. The subsample "3R" appears to be in a better position than the general population. In this group, the level of total victimization was lowest (89.4%). There were no high levels scored in this subsample.



**Figure 4.** Distribution of the pupils in the sample according to levels of total victimization

In subsample "2D," some pupils assessed their total victimization at high and moderate levels, 6.1% and 8.5%, respectively, compared with the majority of the students (85.4%), who rated the level of their total victimization at school as low. These indices do not define an educational environment of complete victimization; the results are evidence of certain manifestations of various types of victimization.

The students in subsample "1M" were exposed to aggression from their coevals and classmates to a greater extent. The number of students who defined the level of victimization as low was 65.5% whereas 44.5% of the students defined their level of victimization as moderate or high.

An analysis of the results identifies the dominant type of victimization in the subsamples. Displaced aggression is the dominant type in all three subsamples (as well as according to the overall index — 55.1%). Of the pupils in the study, 68.0% were exposed to displaced aggression in group "3R", and 21.4% of the respondents in this group were exposed to physical aggression. Of the pupils, 10.6% were victims of social aggression in subsample "3R". Of the pupils, 57.3% were exposed to displaced aggression from their classmates in group "2D"; 24.4% of the respondents were exposed to physical aggression, and 18.3% of the students were exposed to social aggression in group "2P". Of the pupils, 40.2% experienced displaced aggression in subsample "1M," and 31.2% of the respondents in this group were exposed to physical victimization. In group "1M," 28.6% of the pupils experienced social aggression and manipulation.

Insignificant differences in the dominant types of victimization in the educational environment of these schools may be results of both external and internal factors. The most significant factors are groups of pupils, ethnic and cultural composition, peculiarities of the educational system, relationships between “a teacher — a pupil”, the individual and personal characteristics of pupils, and teachers.

We identified confidence as a personality trait based on positive self-esteem and positive experiences with solving social tasks as criteria of a pupil's psychological safety. However, a pupil's increased anxiety can lead to a decline in self-esteem and painful experiences.

To study the level and nature of school anxiety, we used Fillips' methods to diagnose school anxiety level, having defined common school anxiety, experiences of social stress, and fear of self-expression as the most significant factors that characterize a pupil's psychological safety. The intensity of these factors in the pupils is shown in Table 2.

**Table 2.** Indices of the factors of school anxiety (in points)

Pupils under study	Common anxiety	Experience of social stress	Fear of self-expression
1M	15.0	6.0	4.0
2D	10.0	5.0	2.0
3R	8.0	5.0	3.0

The analysis of the results according to certain factors of school anxiety shows the highest level of all indices in subsample “1M”. In the other two groups, indices of anxiety were at moderate and low levels. A more detailed examination of the factor of common anxiety indicated the levels of its occurrence.

An analysis of the distribution results of the pupils by levels indicates that moderate (normal) levels of common school anxiety are typical for the sample group as a whole. Higher levels of school anxiety in subsample “1M” (18.7% of the pupils) are conspicuous against the general background. Such pupils can display emotional instability and often experience worry and uneasiness. The pupils in subsamples “2D” and “3R” worried less; the level of anxiety was normal in both groups.

**Table 3.** Distribution of the pupils by types of ethnic identity with the indices of the corresponding type intensity

Types of ethnic identity					
En	Ei	PEi (Norm)	Ee	Eis	Ef
Indices of intensity of each type of ethnic identity in points					
13.6	14.0	14.6	11.0	0.0	0.0
Distribution of the pupils according to the types of ethnic identity					
17.7	11.8	58.7	11.8	0.0	0.0

*Note.* The following abbreviations are used: En — ethno-nihilism, Ei — ethnic indifference, PEi — positive ethnic identity (Norm), Ee — ethno-egoism, Eis — ethno-isolationism, Ef — ethno-fanaticism.

Another important factor that determines the level of school anxiety in the multicultural educational environment is social stress, which may be a result of the transformation of ethnic identity.

To identify the level of ethnic intolerance, we used the methods of evaluation of ethnic identity types by G.U. Soldatova and S.V. Ryzhova. We noted two of six scales of the questionnaire, ethno-egoism and ethno-isolationism, that correspond to different types of ethnic identity. The results for the entire sample of students ( $n = 127$ ) according to the six scales are presented in Table 3.

The majority of students (58.7%) share an ethnic identity that corresponds to the norm, i.e., a positive ethnic identity. Ethno-nihilism was identified in 17.7% of the pupils; for this category of pupils, ethnic background is not of critical importance. Ethno-egoism was displayed by 11.8% of the pupils, for example, in tense or irritating situations with pupils of other nationalities. The same number of students (11.8%) displayed ethnic indifference, i.e., uncertainty regarding their ethnic background. The pupils who demonstrated this type of ethnic identity were inclined to show more tolerance toward students of different cultures.

Types of ethnic identity such as ethno-isolationism and ethno-fanaticism were not displayed by the pupils, which indicates an absence of a belief in the supremacy of their nation in the group and an absence of xenophobia.

Consequently, the level of “negativism” toward their nation is low in the group as a whole, and there is no vivid separation of their ethnic group compared with other groups.

To determine the results of evaluating psychological safety, we introduced the integrated index of psychological safety condition, which was calculated by summarizing all of the data from the chosen criteria: satisfaction, protection, and self-confidence. The empirical data revealed the current condition of psychological safety of the entire student sample. Then, all of the criteria of psychological safety were subjected to correlation analysis (Pearson  $r$ ), which identified tightness links among the criteria (Table 4).

**Table 4.** Correlation matrix of interrelations of the criteria of pupils’ psychological safety in the multicultural educational environment

Criteria of psychological safety	Pearson $r$			
	S	P	Sc	Ii
S	×	0.58	0.45	0.79
P		×	0.55	0.82
Sc			×	0.61

*Note.* The following abbreviations are used in the table: S – satisfaction; P – protection; Sc – self-confidence; Ii – integrated index.

The analysis of the statistical processing of the results of pair correlation indicated the following:

- 1) There is a direct correlation among all of the criteria of psychological safety, including the integrated index.

- 2) There is a positive relation between criteria **S** and **P**. The correlation coefficient in this case was  $r = 0.58$  (level of significance  $p=0.05$ ), which indicates a moderate correlation.
- 3) There is a positive relation between criteria **P** and **Sc**. The correlation coefficient in this case was  $r = 0.55$  (level of significance  $p=0.05$ ), which indicates a moderate correlation.
- 4) There is a positive relation between criteria **Ii** and **Sc**. The correlation coefficient in this case was  $r = 0.61$  ( level of significance  $p=0.05$ ), which indicates a moderate correlation.
- 5) There is a positive relation between the criteria **Ii** and **S**. The correlation coefficient in this case was  $r = 0.79$  ( level of significance  $p=0.05$ ), which indicates a strong correlation.
- 6) There is a positive relation between criteria **Ii** and **P**. The correlation coefficient in this case was  $r = 0.82$  ( level of significance  $p=0.05$ ), which indicates a strong correlation.

Notably, the presence of a correlation does not establish the sequence of cause and effect but only indicates that two variables are interrelated to a greater extent than one would expect by random coincidence.

The research findings on students' psychological safety in multicultural educational milieu led to the following conclusions:

- Students' psychological safety level is defined by the intensity of the criteria in the following order of significance: 1) protection, 2) satisfaction, and 3) self-confidence. Being on good terms with other members of the educational environment, having parents' and teachers' support, having classmates' sympathy and experiencing a low level of aggression from classmates and teachers positively affect protection. The high comfort level of the class's psychological atmosphere, mutual understanding and contact with teachers, confidence in teachers, mutual aid and support between counterparts and an absence or low level of aggression in classmates and other students in the school favorably affect pupils' self-satisfaction as a subject of activity and social relations. The high level of pupils' relying on teachers in difficult situations, children's mutual aid and support, low aggression levels of classmates and older students and a democratic style of teaching influence self-confidence.
- According to students, the essential characteristics of safety in an educational environment, regardless of school category and type, are being able to ask for help, protection of personal dignity, interaction with other students, and self-respect.
- The highest level of protection from mental violence in interactions and satisfaction with the educational environment indicative of pupils' psychological safety is in subsample "2D" (district school). This is a "small town" or district center school. The number of schools in towns at the district level is less than in regional centers; thus, the students attending a school generally live in the same community and are well-acquainted with one another.

## Conclusion

This study examines pupils' psychological safety in a multicultural educational environment. Because of our modern multicultural society, the necessity to preserve students' psychological safety is extremely important. The educational environment is the place in which key activities occur and a pupil's personality and primary characteristics develop. Thus, the quality of the educational environment is the primary factor in a pupil's psychological safety. The quality of the educational environment is defined by its ability to meet the basic needs of children. There is a need for safety, recognition, acceptance, esteem, social approval, love, for maintaining and increasing self-evaluation, for satisfaction and the development of cognitive needs and the need for labor and significant activity. Satisfying these needs enables a child to preserve his physical and mental health.

Creating an optimal microenvironment and a favorable moral and psychological climate in the classroom contributes significantly to students' psychological safety in a multicultural educational milieu. The need to understand and accept another culture with its unusual traditions, behavior and communication peculiarities defines the direction for future research on teachers' polyethnic competence levels.

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## **Intellectual and personality factors in the achievement of high exam effectiveness in first-year Russian university students**

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The goals set forth in regulatory documents for the development of Russian education presuppose quantitative evaluation of factors and conditions that ensure students' achievement of high competence, personality development, and self-realization. Evaluation of intellectual and personality characteristics of first-year university students and study of the relationship among these characteristics thus become important tasks.

The research objective was to evaluate relationships among social and abstract-logical types of intelligence, personality characteristics, and exam effectiveness (performance).

The study sample was made up of 900 first-year university students (55.2% female and 44.8% male) from Tomsk State University who filled in paper-and-pencil forms in Russian: The Evaluation of Choice in Conflict Situations Questionnaire, Raven's Progressive Matrices, the Self-Organization of Activity, the Reflexivity Type Assessment Test, the Self-Determination Scale, the Satisfaction with Life Scale, and the World Assumptions Scale. Scores on the Unified National Examination in Mathematics (UNE in Mathematics) and the first exam results at the university were used to measure academic performance. The data were statistically processed using descriptive analysis, correlation analysis, and factor analysis.

The preference for compromising and collaborating strategies indicates a high level of social intelligence and contributes to socio-psychological adaptation of young people to conditions of university education that are new to them, which require greater independence and activity. Social intelligence and abstract-logical intelligence are relatively independent intelligence types.

Social intelligence and personality characteristics are not determinants of scores on the UNE in Mathematics. Probably the process of educating students in mathematics in the graduating classes of Russian secondary schools is replaced by training to solve problems on the UNE, so that students' individual characteristics in preparation for the test are no longer factors that influence exam effectiveness. A disparity between social and abstract-logical types of intelligence is accompanied by low academic effectiveness. Proportional development of social and abstract-logical types of intelligence may be an important factor in achieving high academic effectiveness.

**Keywords:** social intelligence, abstract-logical intelligence, academic achievement, personality characteristics, higher professional education

## Introduction

A number of studies have shown that there is no general agreement on the nature and definition of intelligence among scientists. Existing approaches to intelligence as an object of study are inconsistent. At the same time, around the world shows that personality and the intellect are major factors of social development amid constant economic and socio-cultural transformations. Many examples show that the more people use their intelligence, the more successful and sought-after they are in various spheres of life.

R. Lynn and T. Vanhanen report on studies that prove the correlation among intelligence, income, and socio-economic status (Lynn & Vanhanen, 2006). P.A. Freund and H. Holling have proven that intelligence, openness, conscientiousness, and neuroticism significantly predetermine current achievement motivation. Persons with high intelligence show higher motivation and more confidence in their self-realization (Freund & Holling, 2011). S. Kanazawa believes that more intelligent people are more likely to acquire and pass on evolutionarily new preferences and values (Kanazawa, 2012). B.J. Pesta, M.A. McDaniel, and S. Bertsch point out a high correlation between intelligence and the general welfare of an administrative-territorial unit (an American state) ( $r=0.83$ ), as well as a correlation between the welfare of the state and the prevalence of liberal attitudes in the state (Pesta, McDaniel, & Bertsch, 2010).

Recent developments in psychological science show a notable popularity of studies examining types of intelligence, especially social intelligence. G. Allport, E. Vernon, J. Guilford, O. John, S. Kosmitsky, and G.P. Geranyushkina consider social intelligence to be a special type of intelligence that is independent of general intelligence. In accordance with the current concepts of most scientists, we can say that a high level of social intelligence determines a person's effectiveness, social adaptability and success, and leadership capabilities (Kunitsyna et al., 2001; Savenkov, 2005, 2009; Sternberg, 2003).

The relationship between social intelligence and other types of intelligence (general, emotional, and academic) is very important. Resolving this question is non-trivial because of the extreme difficulty of measuring social intelligence, given its high context-dependence and ontological content (Luneva, 2012). The relationship between social intelligence and the personality characteristics that determine a person's effectiveness (basic beliefs about the nature of the world and about one's own abilities, purposefulness, inclination for planning and reflection on one's activity) has so far been little studied.

We believe that the relevance of the relationship between different intelligence types and the role of social intelligence in a person's achievement of high effectiveness has significantly increased because of the reforms which are being carried out in Russia in secondary and higher education. The goals set forth in regulatory documents for Russian education presuppose the quantitative evaluation of factors and conditions that ensure students' high competence, personality development, and self-realization (Abakumova & Bogomaz, 2015). Evaluation of the intellectual and personality characteristics of students in the first year of higher education and study of the relationship among these characteristics thus become important tasks.

We initiated this study with a group of first-year students to achieve two main objectives: to calculate mean values for social and abstract-logical intelligences, and to evaluate relationships among different types of intelligence, personality characteristics, and exam effectiveness.

We hypothesized that different types of intelligence and the personality characteristics of the students make different contributions to high academic achievement. This would lead one to expect that the relationship between students' intellectual and personality characteristics would manifest itself as much as possible in such difficult situations as the Unified National Examination and the first exam at university. This is a new life situation for students, one that requires new professional and personality competencies. For this reason, we chose first-year students to participate in our study.

## **Method**

### ***Sample***

The sample was made up of 900 first-year university students from different departments (faculties) of Tomsk State University. There were 260 students specializing in the natural sciences (Faculty of Chemistry, Faculty of Geology and Geography, Biological Institute), 290 in technical specialties (Faculty of Physics, Faculty of Radiophysics, Faculty of Mechanics and Mathematics, Faculty of Informatics), 450 students in the humanities (Faculty of Psychology, Faculty of Philosophy, Faculty of Philology, International Management Faculty, Higher School of Business, Faculty of History, Institute of Law). The average age of study participants was  $18.5 \pm 1.94$  years (mean and standard deviation). The participants were 55.2% female and 44.8% male.

### ***Study instruments***

To examine the study participants' social intelligence, we applied the Evaluation of Choice in Conflict Situations Questionnaire developed by Russian psychologist Sergey Shcherbakov, based on the Thomas-Kilmann Conflict Mode Instrument (Shcherbakov, 2010). This instrument takes into account the idea that social intelligence vividly manifests itself in difficult or conflict situations. It is a 20-item questionnaire with 7 subscales: Competing, Accommodating, Avoiding, Compromising, Collaborating, Recourse to the mediator, and Giving Caustic Remarks.

In other studies we have shown that high scores for the strategies Compromising and Collaborating or low scores on the strategies Competing, Recourse to the mediator, Giving Caustic Remarks, Avoiding, and Accommodating can indicate the level of social intelligence (Sheketera, Sudneva, & Bogomaz, 2014). Thus we calculated the Social Intelligence index as the arithmetical mean the scores for the Collaborating and Compromising strategies (Sudneva, Karakulova, & Bogomaz, 2010).

A modification of the Raven's Progressive Matrices was applied (Koichu, 2003) to examine abstract-logical intelligence. The number of tasks was reduced to 30 matrices, and only even tasks of the original test were used. Testing time was not limited by us, but the time the student required for the test was recorded in order

to calculate the intellectual effectiveness and productivity of the study participants. Intellectual effectiveness was calculated as a sum of the points for correctly solved tasks according to the test instructions. Intellectual productivity was calculated as a ratio of the total score for correctly solved tasks to the time required for the test, multiplied by 100.

We hypothesized that the ratio of social and abstract-logical intelligences may contribute to the individuality of first-year students. To estimate this ratio, we calculated two ratios, the numerator of which was the Social Intelligence index and the denominator of which was either Effectiveness or Productivity as shown on the Raven's test.

To measure participants' academic effectiveness, we used their scores on the Unified National Examination in Mathematics and their first exam results at the university. It should be noted that in Russia the UNEs for school leavers are now considered as university entrance examinations. Mathematics is one of two compulsory disciplines that are tested.

To examine study participants' personality characteristics that are most related to self-organization of activity, a set of questionnaires including a number of subscales was applied (Bogomaz & Matsuta, 2010; Atamanova & Bogomaz, 2011b). This instrument incorporates the Self-Organization of Activity Questionnaire developed by E.Yu. Mandrikova, with the Purposefulness Index and Rationality Index (Mandrikova, 2007); the Reflexivity Type Assessment Test by D.A. Leontiev (Leontiev et al., 2009); the Self-Determination Scale by K. Sheldon (1995), adapted and modified by E.N. Osin (2010); the Satisfaction with Life Scale by E. Diener (Diener et al., 1985), translated and adapted by E.N. Osin and D.A. Leontiev (Osin & Leontiev, 2008); and the World Assumptions Scale by R. Janoff-Bulman (1989), translated and adapted by O.A. Kravtsova (Soldatova & Shaygerova, 2003), with calculation of the total indices for "Benevolence of the World", "Meaningfulness of the World", and "Self-Worth" (Bogomaz, 2014).

### ***Procedure***

Study participants were asked to fill in several paper-and-pencil forms in Russian. We used the Evaluation of Choice in Conflict Situations Questionnaire (Shcherbakov, 2010) to examine social intelligence. This test was performed by 900 first-year students from different faculties of the university. We applied Raven's Progressive Matrices to examine abstract-logical intelligence. This test was performed by only 317 study participants, because of the difficult testing organization that included the individual work with each study participant and adherence to certain specifications. Testing required good quality of Internet and the same way of the testing procedure for all participants. Study participants came to a test center (computer lab) or tested in soil academic buildings on laptops brought testers. Testing was carried out on a computer with Internet access, in Mozilla Firefox. Study participants received an individual login and password to log in for testing to ensure the confidentiality of data, later, in a processing of the data, the login became an individual participant code. Study participants were included in the system and if they were willing to participate, the giving their consent to research in consent form. Then they passed the test to measure the intelligence.

Mean values of social and abstract-logical intelligence parameters were calculated on the basis of the data collected in a group of first-year students. Social and abstract-logical intelligence parameters were simultaneously evaluated in part of the study sample, as well as personality characteristics and exam effectiveness. This allowed us to analyze the correlations between the parameters under study. The data were organized into a database and statistically processed using descriptive analysis, correlation analysis, and factor analysis in Statistica 6.0 software licensing.

## Results

At the first stage of the study, we calculated mean values for social and abstract-logical intelligence parameters. Statistical results indicated that in case of an interpersonal conflict students prefer such constructive strategies as Compromising and Collaborating. The unconstructive strategy Giving Caustic Remarks is the least preferred (see Table 1).

**Table 1.** Mean values of parameters of the Evaluation of Choice in Conflict Situations Questionnaire (in points) in a group of first-year students (n = 900)

Parameters	Mean	Standard Deviation
Compromising	97.1	15.7
Collaborating	84.8	17.8
Avoiding	68.6	16.5
Competing	62.7	16.7
Accommodating	62.2	16.3
Recourse to the mediator	58.4	15.9
Giving Caustic Remarks	52.4	26.2
Social Intelligence index	91.0	15.4

*Note.* The social intelligence index is the arithmetical mean between the Collaborating and Compromising strategies.

The developmental level of analytical abilities of first-year students (n = 317) that was evaluated using Raven's Progressive Matrices is presented in Table 2.

**Table 2.** Mean values of parameters of Raven's Progressive Matrices in a group of first-year students (n = 317)

Parameters	Mean	Standard Deviation
Intellectual effectiveness (in points)	103.0	23.4
Intellectual productivity (in conventional units)	18.0	6.06

We also calculated means of personality characteristics and basic beliefs in a group of first-year students. These means were within the range of normative values defined by the authors and developers of the instruments used in this study.

Correlation analysis showed only weak correlations between social and abstract-logical types of intelligence. The maximum value of the correlation was observed between the Compromising strategy and Intellectual Effectiveness on the Raven's test:  $r = 0.18$ ;  $p = 0.005$ ;  $n = 254$ .

The relationship between social intelligence and personality characteristics was evaluated in a group of first-year students. Correlation analysis showed significant negative correlation between preference for the Avoiding strategy and such parameters as Inclination for Self-Organization of Activity and the Purposefulness index (see Table 3). Students' preference for the Compromising strategy is positively correlated with Systemic Reflection. The preference for the Collaborating strategy is positively correlated with the Inclination for Self-Organization of Activity and Systemic Reflection.

**Table 3.** Significant correlations between social intelligence parameters and personality characteristic parameters ( $n = 792$ )

Personality characteristics	Avoiding	Social Intelligence Compromising	Collaborating
Inclination for Self-Organization of Activity	$r = -0.25$ ; $p = 0.00$	$r = 0.015$ ; $p = 0.000$	$r = 0.28$ ; $p = 0.00$
Purposefulness index	$r = -0.30$ ; $p = 0.00$	$r = 0.08$ ; $p = 0.014$	$r = 0.18$ ; $p = 0.000$
Systemic Reflection	$r = -0.06$ ; $p = 0.021$	$r = 0.25$ ; $p = 0.00$	$r = 0.30$ ; $p = 0.00$
Rationality index	$r = -0.09$ ; $p = 0.005$	$r = 0.15$ ; $p = 0.000$	$r = 0.26$ ; $p = 0.00$

We used correlation analysis to study the relationship between social and abstract-logical types of intelligence, personality characteristics, and exam effectiveness in mathematics, finding that there were no significant correlations between preference of communicative strategies and scores on the UNE in mathematics. Personality characteristics are also not correlated with UNE scores in mathematics. This may mean that social intelligence and personality characteristics do not make a significant contribution to the achievement of high scores on the UNE in mathematics.

Exam effectiveness on the UNE in mathematics correlates positively with Intellectual Productivity on the Raven's test ( $r = 0.27$ ;  $p = 0.00$ ;  $n = 212$ ). However, this relationship is weaker than we expected. The relationship between exam effectiveness and Intellectual Productivity turned up to be even weaker ( $r = 0.13$ ;  $p = 0.015$ ). Intellectual Productivity is a more important indicator of a high level of abstract-logical intelligence as compared to the indicator of Intellectual Effectiveness.

Correlation analysis also showed that Intellectual Effectiveness and Intellectual Productivity are not correlated with personality characteristics and basic beliefs in the group of first-year students.

Correlation analysis also showed that the ratio, the numerator of which was the Social Intelligence index and the denominator of which was effectiveness of the



Raven's test, does not correlate with exam effectiveness on the UNE in mathematics, personality characteristics, and basic beliefs. A similar situation is observed with the ratio, the numerator of which was the Social Intelligence index and the denominator of which was Productivity on the Raven's test.

It might be assumed that the absence of significant correlations among intellectual parameters, personality characteristics, and exam effectiveness in mathematics may be associated with the gender of study participants. But correlation analysis carried out separately for the female sample and the male sample did not confirm this hypothesis. Significant correlations between parameters of social and abstract-logical types of intelligence and exam effectiveness in mathematics were absent in both samples (Matsuta, Bogomaz, & Sudneva, 2014).

The factor structure of the parameters of social and abstract-logical types of intelligence, personality characteristics, and academic effectiveness was studied in a group of first-year students. Eleven indicators were taken into account as a source of data for factor analysis. Principal component analysis with a normalized varimax rotation was conducted in the study sample, which consisted of 129 girls and boys. The number of factors required for the examination was determined using the scree test proposed by R. Cattell. Factor analysis identified 4 factors explaining 60.6% of the total variance in the correlation matrix. A significant criterion was factor loading greater than 0.50.

Factor analysis confirmed that exam effectiveness in mathematics is associated only with Effectiveness and Productivity on the Raven's test (see Table 4, Factor 2). The Social Intelligence index is associated only with basic beliefs about Benevolence of the World and Meaningfulness of the World (see Table 4, Factor 4).

**Table 4.** The factor structure of social and abstract-logical types of intelligence, personality characteristics, and academic effectiveness

Parameters	Factor 1	Factor 2	Factor 3	Factor 4
Exam scores in mathematics	0.04	<b>0.57</b>	0.27	0.33
Intellectual Effectiveness	-0.14	<b>0.78</b>	0.09	0.08
Intellectual Productivity	0.04	<b>0.78</b>	-0.20	-0.17
Purposefulness index	<b>0.79</b>	-0.12	0.20	-0.15
Rationality index	-0.02	0.04	<b>0.79</b>	-0.10
Systemic Reflection	0.11	0.01	<b>0.67</b>	0.22
Benevolence of the World	0.45	-0.04	-0.14	<b>0.58</b>
Meaningfulness of the World	0.04	-0.09	0.08	<b>0.71</b>
Self-Worth	<b>0.81</b>	-0.00	0.12	0.18
Self-Determination	<b>0.80</b>	0.03	-0.14	0.15
Social Intelligence index	0.00	0.31	0.10	<b>0.64</b>
Explained variance	2.16	1.67	1.31	1.52
Percentage of total explained variance	0.20	0.15	0.12	0.14

At the second stage of the study, we investigated the relationship among social and abstract-logical types of intelligence, personality characteristics, and academic effectiveness, as measured by students' first exam results at the university. In university education, the relationship between exam effectiveness and the parameters under study changes compared to earlier years. Personality characteristics and social intelligence of first-year students become significant factors in the achievement of high exam effectiveness (or high marks on the exam). This pattern is particularly clearly manifested in the group of first-year students of the Faculty of Radiophysics (see Table 5).

**Table 5.** Significant correlations between exam scores in mathematics and physics, and social intelligence and personality characteristics in the group of first-year students of the Faculty of Radiophysics ( $n = 38$ )

Social Intelligence and Personality Characteristics	Exam Scores	
	Mathematics	Physics
Collaborating	$r = 0.34$ ; $p = 0.04$	$r = 0.32$ ; $p = 0.05$
Inclination for Self-Organization of Activity	$r = 0.43$ ; $p = 0.01$	$r = 0.35$ ; $p = 0.03$
Purposefulness index	$r = 0.40$ ; $p = 0.01$	$r = 0.29$ ; $p = 0.08$
Rationality index	$r = 0.38$ ; $p = 0.02$	$r = 0.34$ ; $p = 0.04$
Meaningfulness of the World	$r = 0.33$ ; $p = 0.04$	$r = 0.43$ ; $p = 0.01$
Self-Worth	$r = 0.37$ ; $p = 0.02$	$r = 0.23$ ; $p = 0.17$
Self-Determination	$r = 0.19$ ; $p = 0.27$	$r = 0.37$ ; $p = 0.02$

According to Table 5, students' first mathematics and physics exam scores are associated with such personality characteristics as Inclination for Self-Organization of Activity, Purposefulness, Rationality, Self-Determination, Meaningfulness of the World, and Self-Worth.

The more the first-year students of the Faculty of Radiophysics preferred the Collaborating communicative strategy in conflict situations, the higher were their first mathematics and physics exam scores. It is important to note that this correlation was not found among students of other faculties. In the sample group of first-year students of the Faculty of Radiophysics, there is a significant positive correlation between Intellectual Effectiveness on the Raven's test and exam effectiveness in mathematics:  $r = 0.39$ ;  $p = 0.00$ ;  $n = 53$ . However, in this group of students there is no correlation between Intellectual Effectiveness and the first exam results in mathematics and physics.

In the group of first-year students of the Faculty of Chemistry, there is no significant correlation between intellectual effectiveness on the Raven's test and exam effectiveness in mathematics. However, in this group of students there are correlations between intellectual productivity and the scores on the first exam in general and inorganic chemistry ( $r = 0.44$ ;  $p = 0.01$ ;  $n = 30$ ) and inorganic chemistry ( $r = 0.40$ ;  $p = 0.03$ ;  $n = 31$ ). Correlations between exam scores and social intelligence and personality characteristics were not found.

However, significant correlations were found when analyzing the ratio of social and abstract-logical types of intelligence. The ratio, the numerator of which was Social Intelligence index and the denominator of which was Productivity on the Raven's test, was negatively correlated with the scores in mathematics ( $r = -0.46$ ;  $p = 0.03$ ;  $n = 23$ ) and chemistry ( $r = -0.46$ ;  $p = 0.04$ ;  $n = 20$ ). This means that the stronger the disproportion between social and abstract-logical types of intelligence, the lower the academic effectiveness of first-year students. In this case, the disproportion is a combination of low abstract-logical intelligence and high social intelligence.

In the group of first-year students of the Faculty of Philosophy, there is a weak correlation between Intellectual Productivity on the Raven's test and exam scores in mathematics:  $r = 0.26$ ;  $p = 0.05$ ;  $n = 61$ . In this group of students there is a correlation between Intellectual Effectiveness on the Raven's test and exam scores in the science of law:  $r = -0.32$ ;  $p = 0.05$ ;  $n = 40$ .

Exam scores in history revealed negative correlations with Accommodating ( $r = -0.50$ ;  $p = 0.01$ ;  $n = 27$ ) and with the ratio, the numerator of which was Social Intelligence index and the denominator of which was Effectiveness on the Raven's test ( $r = -0.50$ ;  $p = 0.01$ ;  $n = 26$ ). Once again we observe a pattern: The stronger the disproportion between social and abstract-logical types of intelligence, the lower the academic effectiveness of the students.

In the group of first-year students of the Faculty of History, there is a very strong correlation between such parameters of abstract-logical intelligence as Intellectual Effectiveness and Productivity and exam scores. Mathematical disciplines are not in the curriculum of the first term in this Faculty, but correlations between abstract-logical intelligence and exam scores were found in practically all the historical disciplines (see Table 6). Thus, it can be concluded that analytical abilities determine the exam success of these students in almost all historical disciplines.

**Table 6.** Significant correlations between abstract-logical intelligence and exam scores in the group of first-year students of the Faculty of History

Abstract-Logical Intelligence	Exam Scores				
	Contemporary History of Europe and America	History of the Ancient East	History of Russia	Archaeology	History of Primitive Society
Intellectual Effectiveness	$r = 0.45$ ; $p = 0.01$ ; $n = 35$	$r = 0.51$ ; $p = 0.01$ ; $n = 29$	$r = 0.18$ ; $p = 0.26$ ; $n = 29$	$r = 0.51$ ; $p = 0.02$ ; $n = 21$	$r = 0.45$ ; $p = 0.04$ ; $n = 21$
Intellectual Productivity	$r = 0.32$ ; $p = 0.06$ ; $n = 35$	$r = 0.63$ ; $p = 0.00$ ; $n = 29$	$r = 0.35$ ; $p = 0.03$ ; $n = 29$	$r = 0.64$ ; $p = 0.00$ ; $n = 21$	$r = 0.60$ ; $p = 0.00$ ; $n = 21$

Correlations between exam scores and the preference of communicative strategies were not found in the group of first-year students of the Faculty of History.

However, a correlation was shown between the ratio, the numerator of which was Social Intelligence index and the denominator of which was Productivity on

the Raven's test, and exam scores in history of the Ancient East ( $r = -0.49$ ;  $p = 0.01$ ;  $n = 26$ ), archaeology ( $r = -0.54$ ;  $p = 0.01$ ;  $n = 20$ ), and history of primitive society ( $r = 0.55$ ;  $p = 0.01$ ;  $n = 20$ ). This allows us to point out a pattern: the disparity between social and abstract-logical types of intelligence accompanied by low academic effectiveness.

Weak correlations were found only between exam scores in the history of Russia and some personality characteristics of students of the Faculty of History (see Table 7).

**Table 7.** Significant correlations between exam scores in history of Russia and personality characteristics in the group of first-year students of the Faculty of History ( $n = 63$ )

Personality Characteristics Parameters	Exam Scores in History of Russia
Purposefulness index	$r = 0.27$ ; $p = 0.03$
Systemic Reflection	$r = 0.25$ ; $p = 0.05$
Life Satisfaction	$r = 0.25$ ; $p = 0.05$

These facts suggest that exam scores in the history of Russia are connected with such personality characteristics of first-year students of the Faculty of History as Purposefulness, Rationality, and Life Satisfaction. In other words, personality characteristics of students (on a par with intelligence parameters) are important factors in achieving high exam effectiveness.

## Discussion

In our study, we had set a goal to calculate mean values of social and abstract-logical intelligence parameters, and to evaluate relationships among different types of intelligence, personality characteristics, and exam effectiveness in a group of first-year students.

The calculated mean values of social and abstract-logical types of intelligence in a group of first-year students presented in Tables 1 and 2 may be taken into account in the monitoring of educational effects in the university, as well as in the design of experiments studying the brain processes that underlie intellectual activity.

The findings of previous studies analyzing and evaluating social and abstract-logical intelligence, personality characteristics, and basic beliefs of first-year students, suggest a quite high potential of girls and boys who have entered university (Sudneva, Karakulova, & Bogomaz, 2013).

Our results show that students prefer constructive communicative strategies, Compromising and Collaborating, in case of conflict. The unconstructive strategy Giving Caustic Remarks is the least preferred. This indicates a high level of social intelligence. We believe that this preference may contribute to socio-psychological adaptation of young people to the new conditions of university education, which require greater independence and activity. This raises the question: "Does this adaptation increase or decrease in the process of university education?"

An important question for us was the relationship between social and abstract-logical types of intelligence. The data show that social intelligence and abstract-log-

ical intelligence are relatively independent types of intelligence in the pre-adult age. The combination of these types of intelligence can determine unique individual and typological characteristics of girls and boys. This uniqueness can be increased at the expense of possible relationships between intellectual abilities and basic beliefs, and personality characteristics that are the most related to activity: Purposefulness, Inclination for Planning and Self-Organization of Activity, Systemic Reflection, and Life Satisfaction. The data show that abstract-logical intelligence does not correlate with the above-listed personality characteristics of the girls and boys. On the contrary, it was found that the higher the social intelligence, the greater the Purposefulness, Rational Attitude to Activity, Inclination for Self-Organization of Activity, and Systemic Reflection. In other words, high social intelligence of the students correlates positively with those of their personality characteristics that are responsible for self-regulation of activity (Matsuta & Bogomaz, 2014). On the other hand, students who prefer to avoid solving interpersonal problems in case of conflict (which is an indicator of low social intelligence), tend to have low Purposefulness and low Inclination for Self-Organization of Activity.

It is important to emphasize that the correlation analysis shows that social intelligence is correlated with psychological security and with such basic beliefs as Self-Worth. This indicates that the stronger the students' ability to navigate interpersonal relations and communicative regulations, and the more the students are prepared to collaborate (which is an indicator of high social intelligence), the more they feel psychological security and the more they appreciate their own personalities.

Another important question for us in this study was about the degree of influence of different intelligence types and personality characteristics on exam effectiveness. Based on published data, social and abstract-logical types of intelligence and personality characteristics may be considered as determinants of academic performance and exam effectiveness. However, correlation and factor analysis showed that only abstract-logical intelligence was in some degree associated with exam effectiveness in mathematics.

Social intelligence and personality characteristics are not correlated with scores on the UNE in mathematics in the Russian educational system. That is, they are not its determinants. These findings are consistent with those of another study: Yu.A. Dodonova and T.N. Tikhomirova showed that social intelligence of schoolchildren is not correlated with their school performance (Dodonova & Tikhomirova, 2010).

This may be explained by the fact that the educational process in graduating classes of Russian secondary schools is replaced by a training process aimed at solving problems on the UNE. Many school teachers and educational specialists point out this fact (Bazarov & Shevchenko, 2012; Abakumova & Bogomaz, 2015).

In this "teaching to the test", teachers may regard schoolchildren's personalities as negative factors which they need to neutralize, as became clear from interviews with schoolteachers. As a consequence, the relationship between intellectual and personality characteristics and exam effectiveness may be lost. But, as the results of our study have shown, in the process of such training the relationship between schoolchildren's exam effectiveness and intellectual abilities can be significantly weakened. If our reasoning is correct, the question arises, "What does the UNE

measure?" We can hypothesize that the UNE largely shows not schoolchildren's personal achievements, but the organizational quality of the training process for taking the UNE.

Contrariwise, under conditions of university education, when the subjects of educational activity are provided with significant self-dependence and none of the teachers trains students for their exams, the relationships between exam effectiveness, on the one hand, and intellectual abilities, personality characteristics, and basic beliefs, on the other, changes significantly compared with secondary school.

In other words, the individuality of university students plays an essential role in achieving high exam effectiveness. Moreover, their social and abstract-logical types of intelligence, personality characteristics, and basic beliefs become significant.

This pattern is manifested, for example, by students' first exam results at university. Students of the Faculty of Radiophysics have a particularly high significant positive correlation between Intellectual Effectiveness on the Rave's test and exam effectiveness in mathematics.

In the sample group of first-year students of the Faculty of Chemistry, there is a correlation between Intellectual Effectiveness and their first exam results in general and inorganic chemistry.

It was found that social intelligence of first-year students in certain cases becomes a significant factor in the achievement of high scores on mathematics and physics exams. It is significant to note that the ratio of the different intelligence types contributes to the achievement of high scores during the exam. It was further found that the stronger the disparity between social and abstract-logical intelligences (or the more social intelligence has developed compared to abstract-logical intelligence), the lower the exam effectiveness of first-year students.

Exam scores in some disciplines are connected with such personality characteristics of first-year students as Inclination for Self-Organization of Activity, Purposefulness, Rationality, Self-Determination, Life Satisfaction, Meaningfulness of the World, and Self-Worth.

Analysis of the relationship between social and abstract-logical types of intelligence, and academic effectiveness, found that the disproportion between social and abstract-logical intelligence types was accompanied by low academic effectiveness of students. This means that the proportional development of social and abstract-logical types of intelligence may be an important factor in achieving high exam effectiveness.

## Conclusion

This study provided additional evidence for the assertion that social intelligence and abstract-logical intelligence can be regarded as relatively independent intelligence types. The study also clarified the role of intellectual and personality factors in achieving high exam effectiveness of girls and boys in the modern Russian educational system. This is the theoretical significance of the study.

The data show various patterns in relation to exam effectiveness at school and university. Thus, social intelligence and personality characteristics are not related



to exam effectiveness in mathematics, and the role of students' analytical abilities in achieving high exam results is not as high as would be expected. Therefore, we hypothesized that individual characteristics of students, in their training to take the UNE exam, are no longer factors that influence exam effectiveness.

On the other hand, not only the students' analytical abilities, but also their high social competence, the disproportion in social and abstract-logical intelligence types, and some personality characteristics are important factors in learning activity and affect the performance of students at the university.

We are continuing to conduct research in this direction. In particular, we are collecting empirical evidence that social, emotional, and abstract-logical types of intelligence are relatively independent intelligence types (Bogomaz & Gorchakova, 2015). In addition, on the basis of our findings, we have formed different functional groups among students with high and low intellectual abilities, and started a series of experiments with EEG and eye-tracking. The object of these experiments is to identify the brain activity of subjects with different degrees of manifestation of social and abstract-logical intelligence types. The first empirical results have been published (Bocharov, Bogomaz, Savostyanov et al., 2015).

The main practical significance of our study is the opportunity to develop an optimal algorithm for evaluating psychological characteristics of girls and boys who have entered university, and a psychological monitoring algorithm for educational effects at university in accordance with the new Russian Federation Law "On Education".

## Limitations

A limitation of this study is the use of intelligence techniques developed on the basis of various theoretical concepts (Raven's Progressive Matrices and Shcherbakov's Questionnaire). However, at the present time no group of scientists is trying to create a unified paradigm of tests for social, emotional, and abstract-logical types of intelligence.

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