Psychology in Russia: State of the Art
Volume 8, Issue 4, 2015

Russian Psychological Society
Lomonosov Moscow State University

CLINICAL PSYCHOLOGY

Resource function of conceptual and metacognitive abilities in adolescents with different forms of dysontogenesis

Marina Kholodnaya[a*], Andry Emelin[b]

[a] *Department of the Psychology of Abilities and Mental Resources, Institute of Psychology, Russian Academy of Sciences, Moscow, Russia*

[b] *Center of Child Neuropsychology, Moscow, Russia*

* Corresponding author. E-mail: kholod1949@yandex.ru

This study investigated the level of conceptual and metacognitive abilities and their interaction in adolescents with different forms of dysontogenesis. The total sample ($N = 173$) included four groups of young adolescents (11–12 years old): with normal development, with infantile cerebral palsy (CP), with attention deficit hyperactivity disorder (ADHD), and with delayed intellectual development (DID). We measured the adolescents' performance on tests of conceptual abilities (the use of categories at different grades of generalization, the discovery of abstract meaning and implicit connections between concepts) and metacognitive abilities (attention selectivity, as measured by Münsterberg's test and the understanding of hidden pictures, and attention organization, as measured by indices of cognitive styles). The results showed, first, that in comparison with normal adolescents, the adolescents with CP and ADHD had a deficit of metacognitive abilities, but they did not differ in rates of conceptual abilities. As for adolescents with DID, even though they had lower rates of conceptual abilities and attention selectivity, they did not differ from the "norm" group on some indices of attention organization. Second, a tendency for the disintegration of conceptual and metacognitive abilities (as measured by correlation and factor analysis) was most clearly seen in the adolescents with ADHD and DID. The adolescents with CP and ADHD had conceptual (categorial and generative) abilities as a mental resource, and the adolescents with DID had metacognitive abilities as a mental resource. The resource function of conceptual and metacognitive abilities was determined not only by their level but also by the extent of their interaction (integration).

Keywords: dysontogenesis, infantile cerebral palsy, attention deficit hyperactivity disorder, delayed intellectual development, conceptual abilities, metacognitive abilities, mental resource

ISSN 2074-6857 (Print) / ISSN 2307-2202 (Online)

doi: 10.11621/pir.2015.0409
http://psychologyinrussia.com

Introduction

Adolescence is a distinct period of psychological development. On the one hand, it is a sensitive period of intellectual development as this is the time when conceptual thinking develops –"formal operational thought" (Piaget, 1969) or "thinking in concepts" (Vygotsky, 1934/1982); such thinking leads to a qualitative leap in the development of the intellectual resources of a child. On the other hand, there is a marked slowdown in intellectual development at this time (as compared with its dynamics in previous stages of ontogenesis) because of the onset of puberty.

In research on childhood dysontogenesis a "normative approach" was dominant for many years. In this approach specific signs of psychological activity were seen as "standard," and the corresponding group of children was labeled as the "norm"; adolescents with development deviant to this norm and delayed intellectual development were described as having "deficits." Modern scholars rightly suggest that in the case of dysontogenesis one should speak not of developmental deficits but of developmental differences (Akhtar & Jaswal, 2013; Kapp, Gillespie-Lynch, Sherman, & Hutman, 2013; Norbury & Sparks, 2013).

Among the most common forms of dysontogenesis are cerebral palsy (CP), attention deficit hyperactivity disorder (ADHD), and delayed intellectual development (DID). Many studies describe detailed features of the intelligence of children and adolescents with these types of deviant developments (Barkley, 1997; Peneda, Ardila, & Rosselli, 1999; Shipitsyna & Mamaychuk, 2001; Sonuga-Barke, Houlberg, & Hall, 1994; Swanson, Castellanos, Murias, LaHoste, & Kennedy, 1998). The interest of our study is that the state of intelligence of adolescent children with deviant developments differs greatly. In particular, adolescents with CP are a very diverse group in the development of intelligence — they range from having quite good intelligence to having various forms of delayed intellectual development, including manifestations of intellectual disability. The range of symptoms of intellectual disorders in adolescents with ADHD also varies widely, up to signs of intellectual giftedness ("twice exceptional"). There are even broader boundaries of the DID syndrome: this form of dysontogenesis covers children with minimal brain dysfunction, children with learning disabilities (educationally disabled), slow learners, and children who have suffered social and cultural deprivation as a result of poor living conditions. The existence of such an amazing variety of levels of intelligence under the conditions of deviant development is apparently not accidental: it is evidence of the existence of complex compensatory mechanisms.

However, there is still no clarity as to which intellectual qualities (abilities) can be regarded as a resource basis for the intellectual development of the atypical child. From our perspective, conceptual and metacognitive abilities can act as resource factors in the development of intelligence in normal adolescence and in the adolescence of children with dysontogenesis.

Conceptual abilities are intellectual qualities responsible for the formation and evolution of semantic connections, the use of categories with different grades of generalization, the detection and discovery of implicit connections, and the generation of new ideas. In different studies, conceptual abilities are presented as "the ability to do abstract thinking" (Sattler, 1988), "conceptual intelligence" (Li, 1996), "generative thinking" (Ward & Sifonis, 1997), "thinking in concepts" (Vygotsky,

1934/1982), and "semantic, categorial, and generative abilities" (Kholodnaya, 2012).

Metacognitive abilities are intellectual qualities responsible for the involuntary and voluntary regulation of intellectual activity. Their main function is to control information processing. Metacognitive abilities are described as "cognitive control" (Dreisbach, 2012; Morton, Ezekiel, & Wilk, 2011; Sergiyenko, Vilenskaya, & Kovaleva, 2010), "metacognitive control" (Son & Sethi, 2006), "metacognition" (Efkides, 2008; Flavell, 1979;), "executive functions" (Benedek, Jauk, Somer, Arendasy, & Neubauer, 2014; Burgess, 1997), and "inhibition" (Dempster, 1991; Lubow & Gewirtz, 1995).

Thus, conceptual and metacognitive abilities can act as a resource (compensating) factor in the intellectual development of adolescents with different forms of dysontogenesis.

Method

The objective of the study was the identification of the resource functions of conceptual and metacognitive abilities under the conditions of different forms of dysontogenesis. In accordance with the objective of this study and the hypotheses drawn up regarding a selection of adolescents with varying forms of dysontogenesis, we carried out a study of both the conceptual abilities — namely, categorical ability (the search of categories with different degrees of generalization) and generative ability (abstract metaphorical thinking and making implicit connections between concepts) — and the metacognitive abilities (attention selectivity, through the use of indicators of the selection of relevant information, and attention organization, through the use of indicators of the cognitive styles impulsivity/reflectivity and field dependence/field independence).

The total sample included four groups of young adolescents: 51 adolescents from Moscow schools with normal development (the norm group), 42 with infantile cerebral palsy (the CP group), 40 with attention deficit hyperactivity disorder (the ADHD group), and 40 with delayed intellectual development (the DID group).

SPSS Statistics (version 13) was used for data processing.

Methods for measuring conceptual abilities

1. The Classification of Objects method (Vygotsky-Zeygarnik), which focuses on category generalization abilities (the ability to group many objects using different generalization categories).
2. The Explanation of Proverbs method, which assesses metaphorical thinking abilities through the identification of the abstract meaning of proverbs; (two proverbs were used: "All that glitters is not gold" and "Good things come in small packages."
3. The Conceptual Synthesis method, which assesses the ability to make connections between concepts on the basis of three unconnected words (Kholodnaya, 2012).

Methods for measuring metacognitive abilities

1. Münsterberg's test-assess selective attention in finding meaningful words in a series of random letters (the efficiency of selecting relevant words).
2. The Understanding of a Series of Pictures with a Hidden Meaning method assesses selective attention when the relevance of a situation is highlighted. (The participant is shown a series of three pictures; the third picture has an ambiguous meaning that doesn't follow from the two previous pictures.)
3. The Matching Familiar Figures Test (MFFT) by Kagan identifies the cognitive style of impulsivity/reflectivity. (The first six subtests were used.) The test assesses individual differences in attention organization — namely, the ability to involuntarily slow down a response to a multiple-choice question in order to gather information.
4. The Embedded Figures Test (EFT) by Witkin identifies the cognitive style field dependence/independence. (The second part (form B) was used.) The test reveals individual differences in attention organization that are responsible for the involuntary moderation of the field effect.

Results

Mean data values of conceptual and metacognitive abilities in the groups norm, CP, ADHD, DID

The most important result was that there was no difference between adolescents with a normal type of development and adolescents with symptoms of dysontogenesis. However, the differences among the CP, ADHD, and DID groups are worth mentioning. These similarities and differences are analyzed below.

The adolescents with CP in comparison with those in the norm. The norm group and the CP group showed no differences in categorical generalizations (the number of groups and the number of points in the Classification of Objects method), abstract metaphorical thinking (the number of points in the Explanation of Proverbs method), and the construction of relationships between concepts (the number of points in the Conceptual Synthesis method). Furthermore, there were also no differences between these groups in metacognitive abilities (Understanding of a Series of Pictures with a Hidden Meaning, the speed of the first response in Kagan's method, the speed of finding simple figures in a complex image in Witkin's method, correct responses only).However, the children with CP had significantly lower rates of several metacognitive abilities: there was a decrease in attention selectivity while doing Münsterberg's test ($p \leq 0.01$), and the increase in the number of errors when using Kagan's method was a result of the low effectiveness of perceptual scanning in the multiple-choice situation ($p \leq 0.01$). The tasks from Witkin's method proved the most difficult for the CP group. There was a significant increase in the number of refusals in finding simple figures ($p \leq 0.01$) and an increase in the time needed to find simple figures in a complex image (all answers, $p \leq 0.01$).

Thus, adolescents with CP in comparison with those in the norm group had sufficiently preserved conceptual (categorical and generative) abilities. At the

same time there was a decrease in metacognitive abilities (consequently, there was a deficit in voluntary and nonvoluntary control as a result of the reduction in the effectiveness of semantic selection, perceptual scanning, and perceptual structuring).

The adolescents with ADHD in comparison with those in the norm. Adolescents in the ADHD group gave similar results. They showed no difference, compared with the norm group, in retaining conceptual abilities: categorical generalization (number of points; number of groups), abstract-metaphorical thinking (number of points in the Explanation of Proverbs method), and the generation of connections between concepts (number of points in the Conceptual Synthesis method). Furthermore, there were also no differences between these groups in metacognitive abilities (Understanding of a Series of Pictures with a Hidden Meaning, the speed of the first response in Kagan's method, the speed of finding simple figures in a complex image in Witkin's method, correct responses only).

At the same time, there were statistically significant differences in several metacognitive abilities. Adolescents in the ADHD group showed lower effectiveness of semantic selectivity while doing Münsterberg's test ($p \leq 0.01$). Furthermore, they displayed a slower/ inaccurate information-processing strategy when taking Kagan's test: there was a simultaneous increase in the number of errors ($p \leq 0.05$). Also, as in the CP group, adolescents with ADHD found the task in Witkin's method difficult. They showed an increase in the mean time spent locating a simple figure in a complex image (all answers) ($p \leq 0.05$), and a significant increase in the number of failures to find simple shapes in a complex image ($p \leq 0.01$) .

Thus, adolescents diagnosed with ADHD — compared with adolescents in the norm — retained conceptual ability (thus retaining the ability of categorical generalization and the generation of connections between concepts), but there was a marked reduction in metacognitive abilities (consequently, there was a reduction in the effectiveness of semantic selection, perceptual scanning, and perceptual structuring).

The adolescents with DID in comparison with those in the norm. Adolescents in the DID group showed no difference with those in the norm on only in the two indicators of metacognitive abilities (in the latent time of the first response in Kagan's test and in the mean time of finding a simple figure in a complex one in Witkin's test, when taking the correct answers into account).

Participants from the DID group showed significant differences in all indicators of conceptual (categorial and generative) abilities: they were more prone to using a global strategy for sorting objects, making small groups and grouping objects thematically ($p \leq 0.01$); their capacity for abstract-metaphorical thinking and the generation of connections between concepts was lower ($p \leq 0.01$; $p \leq 0.01$).

In addition, there was a decrease in most of the indicators of metacognitive abilities in these children: semantic selection effectiveness in Münsterberg's test was lower ($p \leq 0.01$); there was less ability to choose a relevant characteristic when understanding pictures with a hidden meaning ($p \leq 0.01$); there was an increase in mistakes when undertaking Kagan's method ($p \leq 0.01$); their response time slowed down and there was an increase in the number of refusals when carrying out tasks in Witkin's method ($p \leq 0.01$; $p \leq 0.01$).

Thus, the intelligence of adolescents with delayed intellectual development was characterized by a deficiency of both conceptual and metacognitive abilities.

Correlation analysis

Table 1 shows the number of correlation links at different levels of significance among indicators of conceptual and metacognitive abilities in each of the four groups of adolescents.

Table 1. The number of correlation links at different levels of significance between indicators of conceptual and metacognitive abilities in different groups

Group	Number of correlation links, $p \leq 0.01$	Number of correlation links, $p \leq 0.05$	Total number of correlation links, $0.01 \leq p \leq 0.05$
Norm	16	15	31
CP	26	25	51
ADHD	15	5	20
DID	12	8	20

As can be seen from Table 1, the highest number of links among the different indicators of conceptual and metacognitive abilities can be observed in the CP group (51 links, 26 of them are highly significant). The norm group occupied an intermediate position (31 links, 16 of them are highly significant). In the ADHD and ID groups there was a sharp decline in the number of significant links among indicators of conceptual and metacognitive abilities (20 links, 15 of them are highly significant; 20 links, 12 of them are highly significant, respectively).

In our view, the existence of close links among different types of abilities can be considered a marker for the integration of the intelligence structure and therefore as an indirect manifestation of the resource capacity of intelligence in the CP and norm groups. Characteristically, the most "successful" group was the CP group, perhaps because these children received more favorable learning conditions in the form of individualized additional education and specialized correction programs. In contrast, in the ADHD group and particularly in the DID group, the connections between conceptual and metacognitive abilities were weakened; this result can be interpreted as a reduction in the resource capabilities of intelligence in children with these forms of dysontogenesis.

Factor analysis results

We used factor analysis to study the structure of the relationships among indicators and to reduce the initial number of correlations by moving to new variables (factors). Factor analysis of the data was performed using the principal components method (rotation according to the varimax normalized criterion) with the groups norm, CP, DID, and ADHD separately.

Factor matrix in the norm group. As seen in Table 2, three factors were highlighted in the norm group.

Table 2. Factor matrix in the norm group

Method/Index	Factors (varimax normalized)		
	1 (26.5%)	**2 (21.7%)**	**3 (20.1%)**
Conceptual abilities			
Classification of Objects, points	0.187	–0.170	0.819
Classification of Objects, number of groups	–0.164	–0.120	0.928
Explanation of Proverbs, points	**0.619**	–0.039	0.019
Conceptual Synthesis, points	**0.764**	–0.163	0.126
Metacognitive abilities			
Münsterberg's test, time in seconds	–0.154	0.809	–0.036
Münsterberg's test, number of words found	**0.759**	0.189	0.090
Understanding of Pictures, points	**0.694**	–0.157	–0.006
Kagan's test, response time in seconds	0.258	**0.870**	–0.181
Kagan's test, number of mistakes	**–0.631**	–0.470	–0.350
Witkin's test (mean time; correct answers only), in seconds	–0.251	**0.765**	–0.120
Witkin's test, number of refusals	–0.447	–0.400	**–0.582**
Witkin's test (mean time; all answers), in seconds	**–0.587**	0.309	**–0.590**

Note: The highest weight indicators are noted in bold.

Factor 1, The Integration of Conceptual and Metacognitive Abilities, is made up of two indicators of conceptual abilities (explaining proverbs and making connections between concepts) and three indicators of metacognitive abilities (semantic selection success, perceptual scanning accuracy as a result of the reflective style, and perceptual structuring accuracy as a result of the field-independence style).

Factor 2, Cognitive Tempo, includes only time indicators of metacognitive abilities (taking longer to complete semantic selection, response time on Kagan's test, time needed to find simple shapes in a complex image).

In turn, Factor 3, Perceptual and Conceptual Differentiation, is a combination of indicators of conceptual and metacognitive abilities: the higher the conceptual differentiation (the generation of more categorical groups), the higher the perceptual differentiation (in the form of a trend toward the field-independence cognitive style).

Thus, in the norm group there were pronounced effects of the integration of conceptual and metacognitive abilities (a reduction in the number of factors of up to three, the content of the first and the third factor).

Factor matrix in the CP group. Table 3 presents the results of factor analysis in the CP group.

Table 3. Factor matrix in the CP group

Method/Index	Factors (varimax normalized)			
	1 (25.8%)	2 (23.7%)	3 (16.1%)	4 (14.7%)
Conceptual abilities				
Classification of Objects, points	–0.106	0.221	**0.895**	–0.196
Classification of Objects, number of groups	0.251	0.083	**0.924**	0.120
Explanation of Proverbs, points	–0.184	**0.730**	0.400	–0.151
Conceptual Synthesis, points	–0.576	**0.550**	0.099	–0.067
Metacognitive abilities				
Münsterberg's test, time in seconds	**0.899**	–0.064	0.082	0.182
Münsterberg's test, number of words found	–0.134	**0.746**	0.237	0.176
Understanding of Pictures, points	0.156	**0.807**	0.115	–0.264
Kagan's test, time of response in seconds	**0.894**	0.035	0.058	0.235
Kagan's test, number of mistakes	0.111	**–0.797**	0.139	0.241
Witkin's test, mean time (correct answers only), in seconds	**0.792**	–0.103	0.032	–0.326
Witkin's test, number of refusals	0.045	–0.189	–0.060	**0.962**
Witkin's test, mean time (all answers), in seconds	0.601	–0.244	–0.031	**0.640**

Note: The highest weight indicators are noted in bold.

There are four factors in this group. Factor 2, Integration of Conceptual and Metacognitive Abilities, is of the greatest interest. It is composed of two indicators of conceptual abilities (explanation of proverbs and making connections between concepts) and three indicators of metacognitive abilities (success of semantic selection, ability to distinguish a relevant feature in a hidden image, and accuracy of scanning as a manifestation of the reflective style).

However, the integration effects in the CP group were less pronounced. In particular, the number of factors rose to four: there were two special factors, one of which included only indicators of conceptual differentiation (Factor 3), and the other (Factor 4) included only indicators of perceptual differentiation.

Another impotent factor is Factor 1, Cognitive Tempo, which includes only time indices of metacognitive abilities (similar to Factor 2 in the norm group). It seems that the acceleration/deceleration of time taken in searching for the answer and making a decision in the different types of intellectual activity is a specific trait of adolescent children, regardless of the form of ontogenetic development.

Factor matrix in the ADHD group. Table 4 presents the factor-analysis results in the ADHD group.

Table 4. Factor matrix in the ADHD group

Method/Index	Factors (varimax normalized)			
	1 (28.6%)	2 (20.7%)	3 (13.3%)	4 (10.8%)
Conceptual abilities				
Classification of Objects, points	**0.818**	–0.001	0.090	–0.273
Classification of Objects, number of groups	0.029	**0.769**	0.213	0.199
Explanation of Proverbs, points	**0.837**	0.070	0.222	–0.061
Conceptual Synthesis, points	**0.744**	–0.097	–0.169	–0.076
Metacognitive abilities				
Münsterberg's test, time in seconds	–0.406	0.409	0.532	0.066
Münsterberg's test, number of words found	0.127	0.052	**0.644**	0.118
Understanding of Pictures, points	**0.861**	–0.040	0.153	0.046
Kagan's test, time of response in seconds	–0.176	0.420	**0.613**	–0.306
Kagan's test, number of mistakes	–0.416	0.166	**–0.758**	0.003
Witkin's test (mean time; correct answers only), in seconds	0.001	**0.899**	–0.070	–0.186
Witkin's test, number of refusals	–0.166	–0.179	0.062	0.945
Witkin's test (mean time; all answers), in seconds	–0.161	**0.560**	0.003	**0.769**

Note: The highest weight indicators are noted in bold.

There are four factors in the ADHD group. Factor 1, Conceptual Abilities, includes three main conceptual-ability indicators (categorical generalization, explaining proverbs, and making connections between concepts). In contrast to the results in the norm group, this factor relates to only one indicator of metacognitive abilities (successfully picking out relevant information in understanding hidden images).

The effect of the integration of the indicators of metacognitive and conceptual abilities is partially reflected in Factor 2, Perceptual and Conceptual Differentiation, which includes the number of allocated groups in the method of classification of objects (conceptual differentiation) and the speed of finding a simple figure in a complex image in Witkin's test (perceptual differentiation).

Factor 3, Reflectivity, is of particular importance in understanding the intelligence of children with ADHD. This factor is characterized by the following relationship: the more pronounced the reflectivity (slow/accurate style of information processing), the higher the semantic selectivity (the more accurately meaningful words are found in a series of letters in Münsterberg's tests).

However, we can see an overall increase in the manifestations of the disintegration of conceptual and metacognitive abilities in the ADHD group: first, there are four factors (rather than three as in the case of the norm group); second, indicators of conceptual and metacognitive abilities "fall" into different factors. There was no effect from combining time indices in one factor in the ADHD group.

Factor matrix in the DID group. Factor-analysis results of indicators in the DID group are shown in Table 5.

Table 5. Factor matrix in the DID group

Method/Index	Factors (varimax normalized)			
	1 (27.5%)	**2 (24.7%)**	**3 (11.3%)**	**4 (10.9%)**
Conceptual abilities				
Classification of Objects, points	–0.301	**0.844**	–0.013	–0.214
Classification of Objects, number of groups	–0.252	**0.849**	–0.018	–0.179
Explanation of Proverbs, points	0.076	**0.721**	–0.099	0.347
Conceptual Synthesis, points	–0.292	0.417	–0.354	–0.352
Metacognitive abilities				
Münsterberg's test, time in seconds	**0.841**	–0.076	0.101	0.106
Münsterberg's test, number of words found	–0.162	0.093	–0.054	**0.940**
Understanding of pictures, points	0.079	**0.761**	–0.005	0.226
Kagan's test, time of response in seconds	**0.832**	0.036	0.138	–0.060
Kagan's test, number of mistakes	–0.441	–0.395	0.362	–0.086
Witkin's test (mean time; correct answers only), in seconds	**0.831**	–0.258	–0.077	–0.160
Witkin's test, number of refusals	0.209	0.016	**0.925**	–0.039
Witkin's test (mean time; all answers), in seconds	**0.831**	–0.156	0.449	–0.060

Note: The highest weight indicators are noted in bold.

There are four factors in the ADHD group. A partial integration of conceptual and metacognitive abilities is brought to light only in Factor 2, Conceptual Abilities (this factor combines two indicators: categorical generalization in object classification and explaining proverbs), in which there is one indicator of metacognitive abilities (successfully picking out relevant information in hidden images). However, in comparison with the other groups, the DID group had a more distinct tendency toward the disintegration of conceptual and metacognitive abilities. Thus, Factors 3 and 4 represent separate, unrelated indicators of metacognitive abilities (the number of refusals as a manifestation of lower-level perceptual structuring abilities in Factor 3 and the success of semantic attention in Factor 4).

It is significant that the generative ability (conceptual synthesis) is not included in any of the four factors in the DID group — that is, the role of this conceptual ability in this form of dysontogenesis is sharply reduced, a result that also shows a tendency for intellectual disintegration. Apparently, the weakness of connections between conceptual and metacognitive abilities was the primary weakness in the intelligence of the children with DID.

Factor 1, Cognitive Tempo, is identical to the same factor in the norm and CP groups; this finding confirms the assumption of the universal role of the time aspect of intellectual activity in early adolescence.

Discussion

According to Vygotsky, conceptual thinking is one of the most important mental resources. Formed during adolescence, it qualitatively rebuilds all forms of cognitive activity and allows for the voluntary regulation of behavior (Vygotsky, 1934/1984). Similarly, Vekker noted that conceptual thinking has a top-down, increasing influence on basic cognitive processes by increasing their productivity (Vekker, 1976). As for the role of conceptual thinking, Yasyukova concludes that the formation of conceptual thinking creates a zone of proximal development of the child's intelligence and indicates the potential for the child's further learning at all stages of school education (Yasyukova, 2005).

Another equally important mental resource is the control mechanism of information processing. In this study two forms of involuntary (operational) cognitive control were considered: attention selectivity (the ability to pick out relevant, meaningful words from random letters and the ability to concentrate on relevant characteristics when understanding pictures with a hidden meaning) and attention organization (the effectiveness of perceptual scanning, through the use of indicators of the cognitive style of impulsivity/reflectivity, and the effectiveness of perceptual structuring, through the use of the cognitive style of field dependence/field independence).

The resource capacity of the intelligence of adolescents is determined not only by the level of conceptual or metacognitive abilities but also by the extent of their interaction (integration). A tendency toward the disintegration of conceptual and metacognitive abilities was most clearly seen in the adolescents with ADHD and DID (in the form of a weakening of connections between the indicators of conceptual and metacognitive abilities, which was detected using correlation and factor analysis).

Unfortunately, we have not found empirical studies in which the relationships between conceptual and metacognitive abilities in adolescents with different forms dysontogenesis are examined. However, our findings on the resource functions of conceptual and metacognitive abilities fit well into the cognitive-energetic model by Sergeant (2005), which was developed to explain ADHD and in which a particular importance was attached to the possibility of resource distribution. According to this model a lack of energetic resources can lead to activity defects both in mechanisms of top-down regulation, which lead to a deficit of inhibitions and voluntary attention, and in mechanisms of down-up regulation, which lead to exhaustion and fluctuations in attention. From our point of view, conceptual abilities

are responsible for top-down regulation, which allows the work of generalization mechanisms and the making of new mental content, whereas metacognitive abilities are responsible for bottom-up regulation, which is connected to involuntary control processes dealing with information processing.

Conclusion

The potential resource capacities of the intelligence of adolescents with CP, ADHD, and DID that allow them to keep up with adolescents in the norm group include such mental resources as, first, conceptual abilities as a top-down compensation (primarily in adolescents with CP and ADHD) and, second, metacognitive abilities as a bottom-up compensation (primarily in adolescents with DID). An important compensatory factor for adolescents with a special development type is the degree of interaction (integration) of conceptual and metacognitive abilities. One of the promising lines of the study is clarification of the resource functions of conceptual and metacognitive abilities in adolescents and youth because conceptual thinking and an individual system of self-regulation are formed finally at these stages.

Acknowledgments

We would like to thank all participating children, parents, and teachers. This study was supported by a grant from the Russian Science Foundation (project no. 14-28-00087), Institute of Psychology of the Russian Academy of Sciences.

References

Akhtar, N., & Jaswal, V. K. (2013). Deficit or difference? Interpreting diverse developmental paths: An introduction to the special section. *Developmental Psychology*, *49*(1), 1–3. doi: 10.1037/a0029851

Barkley, R. A. (1997). Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD. *Psychological Bulletin*, *121*, 65–94. doi: 10.1037/0033-2909.121.1.65

Benedek, M., Jauk, E., Sommer, M., Arendasy, M., & Neubauer, A. (2014). Intelligence, creativity and cognitive control: The common and differential involvement of executive functions in intelligence and creativity. *Intelligence, 46*, 73–83. doi: 10.1016/j.intell.2014.05.007

Burgess, P. W. (1997). Theory and methodology in executive function research. In P. Rabbit (Ed.), *Methodology of Frontal and Executive Function* (pp. 81–116). Hove, U.K.: Psychology Press.

Dempster, F. N. (1991). Inhibitory processes: A neglected dimension of intelligence. *Intelligence, 15*, 157–173. doi: 10.1016/0160-2896(91)90028-C

Dreisbach, G. (2012). Mechanisms of cognitive control: The functional role of task rules. *Current Direction in Psychological Science*, *21*(4), 227–231. doi: 10.1177/0963721412449830

Efkides, A. (2008). Metacognition. Defining its facets and levels of functioning in relation to self-regulation and co-regulation. *European Psychologist*, *13*(4), 277–287. doi: 10.1027/1016-9040.13.4.277

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive developmental inquiry. *American Psychologist*, *34*, 906–911. doi: 10.1037/0003-066X.34.10.906

Kapp, S. K., Gillespie-Lynch, K., Sherman, L. E., & Hutman, T. (2013). Deficit, difference, or both? Autism and neurodiversity. *Developmental Psychology, 49*, 59–71. doi: 10.1037/a0028353

Kholodnaya, M. A. (2012). *Psikhologiya ponyatiynogo myshleniya: Ot konzeptual'nuch struktur k ponyatiinum sposobnostyam* [The psychology of conceptual thinking: From conceptual structures to conceptual abilities]. Moscow: Institute of Psychology of the Russian Academy of Sciences.

Li, R. (1996). *A theory of conceptual intelligence: Thinking, learning and giftedness*. N. Y.: Praeger.

Lubow, R. E., & Gewirtz, J. C. (1995). Latent inhibition in humans: Data, theory, and implications for schizophrenia. *Psychological Bulletin, 117*, 87–103. doi: 10.1037/0033-2909.117.1.87

Morton, J. B., Ezekiel, F., & Wilk, H. A. (2011). Cognitive control: Easy to identify but hard to define. *Topics in Cognitive Science*, *3*, 212–216. doi: 10.1111/j.1756-8765.2011.01139.x

Norbury, C. F., & Sparks, A. (2013). Difference or disorder? Cultural issues in understanding neurodevelopmental disorders. *Developmental Psychology*, *49*, 45–58. doi: 10.1037/a0027446

Peneda, D., Ardila A., & Rosselli, M. (1999). Neuropsychological and behavioral assessment of ADHD in seven- to twelve-year-old children: A discriminant analysis. *Journal of Learning Disabilities*, 32, 159–173. doi: 10.1177/002221949903200206

Piaget, J. (1969). *Izbrannye psikhologicheskiye trudy* [Selected works in psychology]. Moscow: Prosveshchenie.

Sattler, J. M. (1988). *Assessment of Children*: *Cognitive Foundations* (3rd ed.). San Diego.

Sergeant, J. A. (2005). Modeling attention-deficit/hyperactivity disorder: A critical appraisal of the cognitive-energetic model. *Biological Psychiatry*, *57*(11), 1248–1255. doi: 10.1016/j.biopsych.2004.09.010

Sergiyenko, E. A., Vilenskaya, G. A., & Kovaleva, Y. V. (2010). *Kontrol povedeniya kak subektnaya regulatsiya* [Behavior control as a subject of regulation]. Moscow: Institute of Psychology of the Russian Academy of Sciences.

Shipitsyna, L. M., & Mamaychuk, I. I. (2001). *Detskiy tserebralniy paralich* [Infantile cerebral palsy]. St. Petersburg: Didaktika Plus Press.

Son, L. K., & Sethi, R. (2006). Metacognitive control and optimal learning. *Cognitive Science*, *30*, 759–774. doi: s15516709cog0000_74

Sonuga-Barke, E. J., Houlberg, K., & Hall, M. (1994). When is "impulsiveness" not impulsive? The case of hyperactive children's cognitive style. *Journal of Child Psychology and Psychiatry*, *35*(7), 1247–1253. doi: 10.1111/j.1469-7610.1994.tb01232.x

Swanson, J., Castellanos, F. X., Murias, M., LaHoste, G. J., & Kennedy, J. (1998). Cognitive neuroscience of attention deficit hyperactivity disorder and hyperkinetic disorder. *Current Opinion in Neurobiology, 8*(2), 263–271. doi: 10.1016/S0959-4388(98)80150-5

Ward, T. B., & Sifonis, C. M. (1997). Task demands and generative thinking: What changes and what remains the same? *Journal of Creative Behavior*, *31*(4), 245–259. doi: 10.1002/j.2162-6057.1997.tb00797.x

Vekker, L. M. (1976). *Psikhicheskiye protsessy. Myshleniye i intellect* [Mental processes. Thinking and intellect] (Vol. 2). Leningrad: University of Leningrad Press, 1976.

Vygotsky, L. S. (1982). Myshleniye i rech [Thinking and speech]. In *Izbrannue trudu* [Compiled works] (Vol. 2, pp. 5–361). Moscow: Pedagogika. (Original work published 1934)

Yasyukova, L. A. (2005). *Zakonomernosty razvitiya ponyatiynogo myshleniya i ego rol v obuchenii* [Patterns of conceptual thinking development and its role in learning]. St. Petersburg: Imaton.

Original manuscript received June 16, 2015
Revised manuscript accepted September 11, 2015
First published online December 30, 2015