

Functioning of memory and attention processes in children with intelligence below average

BACKGROUND

The aim of the research was to assess memorization and recall of logically connected and unconnected material, coded graphically and linguistically, and the ability to focus attention, in a group of children with intelligence below average, compared to children with average intelligence.

PARTICIPANTS AND PROCEDURE

The study group included 27 children with intelligence below average. The control group consisted of 29 individuals. All of them were examined using the authors' experimental trials and the TUS test (Attention and Perceptiveness Test).

RESULTS

Children with intelligence below average memorized significantly less information contained in the logical material, demonstrated lower ability to memorize the visual material, memorized significantly fewer words in the verbal

material learning task, achieved lower results in such indicators of the visual attention process pace as the number of omissions and mistakes, and had a lower pace of perceptual work, compared to children with average intelligence.

CONCLUSIONS

The results confirm that children with intelligence below average have difficulties with memorizing new material, both logically connected and unconnected. The significantly lower capacity of direct memory is independent of modality. The results of the study on the memory process confirm the hypothesis about lower abilities of children with intelligence below average, in terms of concentration, work pace, efficiency and perception.

KEY WORDS

intelligence below average; logical memory; mechanical memory; attention; perception

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AUTHORS' CONTRIBUTION — A: Study design · B: Data collection · C: Statistical analysis · D: Data interpretation · E: Manuscript preparation · F: Literature search · G: Funds collection

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BACKGROUND

The results of studies on various aspects of children's health, conducted under the auspices of the World Health Organization in 2003, indicate that the most frequently diagnosed problem among 6-17-year-old children is learning disabilities (11.5%), followed by attention-deficit/hyperactivity disorder (ADHD) (8.8%), and followed by behavioural problems (6.3%). Prevalent problems at kindergarten age include speech problems (5.8%) and general developmental delay (3.2%). Compared to objective measures of the prevalence of diagnoses, parents recognize emotional, cognitive and behavioural problems of their children much more often. For example, 41% of parents think that their children have learning difficulties and 36% claim that their children are depressive and anxious (Blanchard, Gurka & Blackman, 2006). It can also be concluded from the report that children with developmental problems have lower self-esteem, are more depressive and anxious, have more objectively diagnosed problems at school, skip classes more often, and are less involved in sports and other activities which would make them socialise with their peers. Parents of these children experience more educational difficulties and face more problems in the parent-child relation (Blanchard, Gurka & Blackman, 2006).

Individuals with learning difficulties include a group of children with intelligence below average. These children experience learning difficulties due to certain intellectual limitations and lower level of cognitive abilities, compared to their developmental age. Intelligence below average is a category of an intellectual standard, constituting its lower limit. It means lower cognitive and intellectual abilities without diagnosed mental retardation. Children from this group achieve lower results in intelligence tests (between 70 and 85 points). Since 1980 it has been categorized as an intellectual standard. These children are sometimes referred to as borderline intellectual functioning, because their results are on the border of the intellectual norm and mental retardation. Such a description is used in order to avoid stigmatizing individuals with lower intelligence as people with intellectual 'deficiencies'. Popular terms encountered in the literature of the subject are 'slow learners' (which emphasizes the lower pace of acquiring school material), 'shadow children' or 'grey area kids'.

There are many different reasons why children achieve results confirming that their intelligence is below average. The reasons can be divided into a few distinct groups. The first one is socially and/or educationally neglected children; the main reason here is the lack of appropriate external stimulation. The second one is children characterized by a significantly slower development pace in terms of orientation-cognitive, intellectual and executive processes. The third group includes children with so-called partial cognitive deficiencies, which affect the overall intelligence

result. The fourth group comprises children with mental retardation, who – after intense stimulation – achieve results above 70 points on the full scale. The last group is children who cannot be classified in any of the aforementioned groups (Kostańska, 1995).

The diagnosis and recognition of school problems related to the lower intelligence level are not the basis of directing a child to a special needs school or therapeutic classes. Such children attend state schools, fulfil their duties and meet school requirements for children with average development pace and dynamics. Their difficulties concern first of all abstract and critical thinking and are the reason why they face so many educational failures (Shaw, Grimes & Bulman, 2005), including year repetition. Learning failures are often a source of social problems, especially with peers. Such children are laughed at and threatened, which decreases their self-esteem and confidence, and impedes adaptation to the peer environment. Due to intensifying learning difficulties, especially year repetition, the motivation to learn deteriorates (Ritzema & Shaw, 2012). Incorrect adaptive behaviours and strategies of coping with stress emerge, e.g. playing truant, aggression, neglecting adults (Pitala, 2007; Jankowska & Bogdanowicz, 2012). The inclination to be irritable and hyperactive is sometimes so high that it requires pharmacological treatment and administration of drugs, e.g. risperidone (van Bellinghen & de Troch, 2001).

Borderline intelligence is most frequently diagnosed with school age children, because their lower intellectual abilities are demonstrated mainly in school conditions and cause educational failures. Such children often do not have difficulties in everyday life and achieve a high level of independence due to the mastery of various skills, especially practical ones.

The results of former studies indicate that children with intelligence below average achieved lower results than their peers in various tests assessing cognitive processes. Reasoning disorders were observed, mostly logical and verbal-conceptual ones, accompanied by high concrete thinking, stiffness and lack of originality (Jankowska & Bogdanowicz, 2012). The children found it difficult to understand cause-and-effect relations, and demonstrated inferior skills in terms of abstraction, classification and differentiation of distinct features. Most difficulties appeared when operating on abstract material. Few research projects have focused on cognitive processes other than reasoning, e.g. perception, memory or attention (see Wojnarska, 2001; Kostańska, 1994).

Investigating the specificity of functioning of children with borderline intelligence creates an opportunity to develop appropriate support programmes and equalize their educational opportunities. Creating optimal conditions and multi-aspect support for the developmental potential of children with intellectual disability may enhance their functioning significantly (Shaw, Grimes & Bulman, 2005), and hence prevent the consequences of negative educational experienc-

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es, i.e. psychological, emotional and personality disorders. 'One must not and should not forget about less gifted children. In favourable conditions they may bloom and make a lot of nice surprises for us. However, when deprived of our attention, they will experience problems which will evolve into trouble for all their fellow students and teachers' (Pitala, 2007, p. 65).

The aim of this study was to characterize and describe the specificity of cognitive processes fundamental for school education, i.e. remembering and recalling the memorized content and the ability to focus attention in a group of children with intelligence below average, compared to children with average intelligence. The following aspects were analysed: memory capacity, recall readiness, memorization accuracy, memorization constancy and pace, and the scope of memory, alongside accuracy and attention focus.

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PARTICIPANTS AND PROCEDURE

SUBJECTS

The study group included 27 children aged 10-11 years (average age 10 years 8 months), whose intelligence quotient (IQ) equalled 70-85 points on the full scale, tested with the Wechsler Child Intelligence Scale (WISC-R). The average IQ equalled 78, the lowest 74, the highest 82. The IQ results distribution indicated that the group was homogeneous and not very diverse in this regard. The psychological and pedagogical tests conducted to include children in the study group took place in the psychological and pedagogical counselling centre specific for the school the pupils attended.

The exclusion criterion was having an evaluation report about disorders coupled with intelligence below average, uncorrected visual and auditory impairments, autism, epilepsy and psychomotor hyperactivity.

The control group included 29 pupils aged 10-11 years (average age 10 years and 6 months), assigned to the group on the basis of the WISC-R test. Only those individuals who achieved recalculated results in subscales ranging from 8 to 12 points were assigned to the control group. The average IQ in this group was 102.7 points. In the class teacher's opinion and on the basis of school grades, these children did not demonstrate any learning difficulties.

RESEARCH METHODS

The authors' experimental trials concerning information memorization and recall and learning process were applied in the study on memory. The TUS test (*Test Uwagi i Spostrzegawczości*; Attention and Perceptiveness Test) was used to assess attention.

In the 'Animal' test visual material (a card with pictures of 12 animals) was used (before the test the

author made sure that the child knew all animals). The subject's task was to look at the card for 30 seconds and memorize animals. After the time expired, the children were asked to list the names of the memorized animals. That task assessed the capacity of the direct visual memory, and also required the child to apply some strategy of perceiving and memorizing pictures. The indicators were the following: the number of memorized animals, the number of repetitions and the number of errors.

The 'Words' test determined the pace of mechanical verbal learning of a 12-item list of unrelated nouns. The child was asked to repeat the list of 12 words they heard, until they repeated all words correctly. The indicator was the number of repetitions of the list until the set criterion was met, and the duration of the whole test.

The 'Story' test required the child to remember a story, and checked their understanding and logical memorization. The child had to listen to the story and answer 10 questions concerning its content. The indicator was the number of correct answers.

The last test - 'Interrogation' - required the child to memorize the content of a picture displaying a scene with a few characters involved in various activities. The child had to examine the picture, memorize as many details as possible, and answer 10 closed-ended questions. The indicator was the number of correct answers.

The TUS test (version 6/9) was used to assess the attention abilities. The child had to cross out numbers 6 and 9 from a row for 3 minutes. The test assessed the pace and precision of perception, which required concentration and constant attention focus (Ciechanowicz & Stańczak, 2006). The indicators were the pace of perception work (the number of reviewed digits), the number of errors and omissions.

The study was conducted from November 2012 to May 2013. Statistical analyses were conducted in order to compare the study and control groups, and they included Student's *t*-test (for those variables whose distribution in the study group was compliant with the normal distribution) and the Mann-Whitney *U* test (for those variables whose distribution in the study group was not compliant with the normal distribution). The level of significance was $p < 0.05$.

RESULTS

COMPARISON OF LOGICAL DIRECT MEMORY OF CHILDREN WITH INTELLIGENCE BELOW AVERAGE AND CHILDREN WITH AVERAGE INTELLIGENCE

Results achieved by children from both study groups in the Story and Interrogation tasks were compared in order to verify the hypothesis about different func-

Table 1

Comparison of results achieved in the Story and Interrogation tests in both groups

Variable indicator	Study group N = 27		Control group N = 29		Test value	
	average	SD	average	SD	Z	P
Number of correct answers in the Story test	4.85	1.61	7.90	0.94	-5.822	0.000
Number of correct answers in the Interrogation test	5.56	1.72	8.14	1.06	-5.156	0.000

Table 2

Comparison of the capacity of visual short-term memory of children with intelligence below average and children with average intelligence

Variable indicator	Study group N = 27		Control group N = 29		Test value	
	average	SD	average	SD	Z	P
Number of correctly memorized animal names	6.30	1.64	8.93	1.28	-5.013	0.000
Number of repetitions	1.19	1.00	0.21	0.41	-4.092	0.000
Number of errors	0.41	0.64	0.03	0.19	-2.907	0.004

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tioning of logical direct memory, independent of the sensory modality. In both tasks the children had to memorize logical content and recall it from memory after direct exposure; however, the material differed: verbal in the Story test and visual in the Interrogation test. Since none of the variables had a normal distribution, the Mann-Whitney *U* test was used for inter-group comparison. The results are presented in Table 1.

The presented results indicate significant differences in memorizing logical material between children with intelligence below average and children with average intelligence. The children from the study group memorized significantly less information, which is proved by fewer correct answers. The study group is also characterized by much more diverse results, which is confirmed by the higher standard deviation indicator.

A higher number of answers to questions in the Interrogation test, compared to the Story test, may be explained by better memorization of visual, than verbal, material.

COMPARISON OF VISUAL SHORT-TERM MEMORY CAPACITY OF CHILDREN WITH INTELLIGENCE BELOW AVERAGE AND CHILDREN WITH AVERAGE INTELLIGENCE

The results achieved in the Animal test were used to characterize the capacity of visual short-term memory in both study groups. It was assumed that on the basis of the number of correctly recalled names of animals after a single exposure of the picture, conclusions can be drawn concerning this specific pa-

rameter of memory functioning. The number of repetitions may be an indicator of the lack of full control over the course of recall, i.e. may suggest attention deficits. The number of errors may suggest certain memory process distortions, as well as attention deficits. Empirical distributions of the achieved results were not compliant with the normal distribution; therefore the Mann-Whitney *U* test was used. The results of the inter-group comparisons are presented in Table 2.

As can be concluded from the data presented in the Table, the children with intelligence below average provided significantly fewer animal names. It implies their lower ability to memorize visual material than that of the children with average intelligence. Considering the average capacity of direct memory, estimated to be 7 ± 2 elements, the results in the study group do not imply any disorders in this area, but rather decreased ability to memorize. The number of repetitions and errors was low in both groups, although the differences between them turned out to be statistically significant. Therefore this confirms the assumption about the lack of disorders.

COMPARISON OF THE PACE OF VERBAL MATERIAL ACQUISITION IN CHILDREN WITH INTELLIGENCE BELOW AVERAGE AND CHILDREN WITH AVERAGE INTELLIGENCE

Results obtained by both study groups in the Words test were used to assess the pace of verbal material acquisition. The first indicator was the number of trials, and the second one was the time needed to memorize the 12 given words. It turned out though

Table 3

Comparison of the pace of verbal material acquisition in children with intelligence below average and children with average intelligence

Variable indicator	Study group		Control group		Test value	
	average	SD	average	SD	t/Z	P
Number of trials	4.56	1.28	4.10	0.72	-1.357	0.174 NS
Time	4 min 43 s	53 s	4 min 2 s	46 s	-1.811	0.076 NS
Number of memorized words	8.63	2.29	9.93	1.99	-2.299	0.021*

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Note. Bold font – *t* statistic (Student's *t*-test)

NS – the difference is not statistically significant

* statistically significant difference with $p < 0.05$

Table 4

Comparison of attention functioning in children with intelligence below average and children with average intelligence

Variable indicator	Study group		Control group		Test value	
	average	SD	average	SD	t/Z	P
Perception work pace	302.44	52.91	451.34	91.25	-7.397	0.000
Number of errors	0.93	1.07	0.11	0.15	-4.079	0.000
Number of omissions	5.33	4.25	0.24	0.58	-6.255	0.000

Note. Bold font – *t* statistic (Student's *t*-test)

that the test was difficult for most of the children, and for some it was impossible to complete. Only 6 children (22%) from the study group and 14 children (48%) from the control group completed the task, i.e. memorized the 12-word list. Hence it was assumed during the test that if a child was not able to repeat the word list correctly after 6 repetitions, no further attempts to complete the task were made. Therefore the third indicator was introduced: the average number of memorized words during all trials. The Time indicator's distribution was compliant with the normal distribution, so Student's *t*-test was used. Other variables did not have a normal distribution, hence the Mann-Whitney *U* test was applied. The results are presented in Table 3. The first two indicators present the results of those who completed the task, and the third indicator illustrates the results achieved by all children from both groups.

No statistically significant differences were observed among individuals who completed the task in full and memorized the 12 words in both groups. The subjects from the study group needed a similar number of repetitions and completed the task in a similar time as the children from the control group. However, these indicators were obtained in small groups. The number of memorized words is an indicator which differentiates the two groups and suggests that the children with intelligence below average have greater problems with learning verbal material, compared to the children with average intelligence.

COMPARISON OF ATTENTION FUNCTIONING IN CHILDREN WITH INTELLIGENCE BELOW AVERAGE AND CHILDREN WITH AVERAGE INTELLIGENCE

The results of the TUS test were used to assess the functioning of attention processes. The results are presented in Table 4.

The results presented in Table 4 indicate significant inter-group differences between all indicators of attention process course. In addition, the perception work pace indicator suggests worse functioning of perception processes in the study group. The significantly higher number of omissions in the study group indicates clearly attention deficits.

DISCUSSION OF RESULTS

The group of children with intelligence below average is not the centre of attention of scientists, and there are relatively few works devoted to the characterization of their functioning in various life areas (Jankowska & Bogdanowicz, 2012). The common feature of these children is decreased cognitive abilities, which may be related to emotional, behavioural and socialisation disorders (Kostańska, 1994). It is emphasized that they have thinking abilities, material transformation skills, understanding of logical and semantic relations, abstraction and figurativeness of language, developed below average, but better than

in the case of mentally retarded children (Jankowska & Bogdanowicz, 2012). Few works are devoted to the quality of such cognitive processes as memory, learning and attention (see Kostańska, 1994).

Memory, learning and attention are the basis for acquiring new knowledge and skills. The presented results indicate that children with intelligence below average are characterized by a lower level of performance in terms of these processes.

The first research area was the ability to memorize and recall logically connected information. The source of the information, and at the same time the material to be memorized, was a narrative text and a topical picture. Efficient memorization of verbal or visual data required comprehensive understanding of the story content and application of some strategy of logical memorization. The results revealed that the children from the study group gave significantly fewer correct answers to the questions, which suggests lower efficiency of logical memorization and recall, in the case of both verbal and visual material. The number of correct answers was higher in the case of the visual material, compared to the verbal one, which implies better memorization of graphical than verbal data. These results should be applied in educational practice. In order to enhance the ability to memorize logically connected data in the case of children with intelligence below average, it is necessary first to improve their understanding of the content and look for cause-effect relations in the verbal and visual material. Once this is completed, the children can attempt to memorize and recall. School material one has to memorize throughout the educational process is a set of logically connected information. Children with intelligence below average will achieve better results at school once they understand the content they have to learn first. The second conclusion which can be drawn from this result concerns supporting children in their knowledge acquisition by presenting the material they have to learn in a graphical form, or try to change verbal material into graphical material. It turned out that graphical material is a little easier to study and memorize than linguistically coded material.

The second research area was the ability of children with intelligence below average to memorize logically unconnected material (the so-called mechanical memory). Although in the case of these children this kind of memory constitutes their learning, their ability to memorize the visual material turned out to be poorer than in the case of children with average intelligence.

Since the obtained result (the average number of memorized objects) remains within the range typical of human direct memory (7 ± 2 elements), no disorders in this area can be suspected; decreased ability to memorize seems to be the key element. It is also confirmed by a low number of repetitions and a low number of errors.

As in case of direct memory, also learning logically unconnected material (by a few repetitions) brought worse results in the study group. First of all, more individuals from the control group completed the task in full, i.e. learned all 12 words. However, it is worth underlining that this kind of cognitive activity turned out to be difficult for children aged 10-11 years, independent of their IQ; few children completed the task and met the study of memorization. No differences between the study and control group were observed in terms of the number of attempts and time required to acquire new knowledge – therefore the pace of learning was the same. Secondly, taking into account the average number of words memorized in both groups, children from the study group memorized fewer words during their learning process.

CONCLUSIONS

Summing up, children with intelligence below average have difficulties both with memorizing new, logically connected or unconnected, material. The capacity of their direct memory is significantly lower, independent of modality.

The results of the study of the attention process confirm the hypothesis about lower abilities of children with intelligence below average in terms of concentration, work pace, efficiency, and perception process.

Children with intelligence below average need individualised education, programmes tailored to their cognitive skills and multi-aspect, intense rehabilitation of their deficits (Shaw *et al.*, 2005). Regular exercise of cognitive functions stimulates their development significantly. The awareness of the deficiencies' structure enables the development of more efficient forms of pedagogical and psychological help, and prevents the occurrence of negative psychosocial consequences resulting from educational failures. Therefore it can play a prophylactic function, preventing mental disorders.

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