International Online Journal of Educational Sciences, 2015, 7 (1), 65-78

iojes
www.iojes.net

International Online Journal of Educational Sciences

ISSN: 1309-2707

Effects of the Cognitive Development Method on the Cognitive Development of 10- to 12-Year-old Children

Hatice Kafadar[1] Zafer Akıncı[2] and Belgin Çakır[2]

[1]Abant İzzet Baysal University, Faculty of Arts and Science , Department of Psychology, Bolu, Turkey; [2] Human Psychological Research and Development Institute, İstanbul, Turkey

ARTICLE INFO

Article History:
Received 27.04.2014
Received in revised form
17.09.2014
Accepted 20.09.2014
Available online
01.03.2015

ABSTRACT

In this study, we examined the effectiveness of the Cognitive Development Method, which was designed to solve various problems that may emerge from cognitive processing in daily life, in healthy children. The Cognitive Development Method is a cognitive training program designed to improve the cognitive processing of participants. 201 healthy participants between 10 and 12 years of age were included in the research. Experimental and control groups were tested before and after experimental manipulation. Neuropsychological tests measuring cognitive processes such as memory, attention, problem solving, general ability, planning, and working memory were administered to the participants in both the experimental and the control groups before the experimental manipulation. Following these tests, 131 participants in the experimental group took part in the Cognitive Development Method for 30 days, 5 days a week, 45 minutes a day. Participants in the control group did not receive any training. At the next stage, the neuropsychological tests werere-administered to the participants in both the experimental and the control groups. The final neuropsychological test averages of the participants in the experimental group were higher than those of the participants in the control group. Analysis of variance (ANOVA) was applied to the data obtained from the research. The analyses demonstrated that the Cognitive Training Program affects the cognitive development of children positively.© 01:19 IOJES. All rights reserved

© 2015 IOJES. All rights reserved

Keywords:
Cognitive Development Method, IQ Up Cognitive Development Method, Cognitive development; Cognitive training, Intelligence, Working memory training

Introduction

During the last decade, several methods of cognitive training have been developed to help people effectively use cognitive processing strategies. For healthy people or people who are living with cognitive dysfunction, cognitive training aims to help individuals focus their attention on a specific stimulus for a sustained period of time, to organize stimuli in their mind, to store and remember these stimuli properly through further repetition, and to decrease memory loss in daily life. With these methods, it is possible to teach individuals to properly and effectively use strategies to improve such high-level cognitive functions as problem solving, reasoning, ratiocination, abstract thinking, planning, and decision making. Therefore, it may be possible to avoid problems such as inattentiveness, forgetfulness, coping skill deficiencies, and academic failure as well as failure in business endeavors despite working long hours (Bracy, 1994; Holmes, Gathercole, & Dunning, 2009; Klingberg, 2010; Sternberg, 2008).

In daily life, one of the areas in which these problems are frequently faced is the field of education. Academic failure due to cognitive processing deficiencies is a major problem for children attending school.

[1] Corresponding author's address: Abant İzzet Baysal University, Faculty of Arts and Science, Department of Psychology, 14280 Golkoy, Bolu, Turkey.
Telephone: +90 374 254 10 00
Fax : +90 374 253 46 41
e-mail: haticekafadar@yahoo.com, kafadar_h@ibu.edu.tr
DOI: http://dx.doi.org/10.15345/iojes.2015.01.006

© 2015 International Online Journal of Educational Sciences (IOJES) is a publication of Educational Researches and Publications Association (ERPA)

The cognitive development of children attending school is critical to their academic success. It is believed that the academic success of a child is directly proportional to the dynamic control and management of cognitive processing strategies. Many common problems contribute to this issue, such as overcrowded classrooms; inadequate equipment, laboratories, computers, and libraries; and teacher shortages. Individual differences among children can also lead to the underdevelopment, and improper and ineffective use of cognitive processing strategies and thus academic failure. As a result, sufficient and necessary educational quality cannot be achieved for children receiving education in such a system (Gedikoğlu, 2005).

Several training programs are being developed to enable effective cognitive processing through methods of cognitive training. The target population for these training programs may be either sufferers from cognitive dysfunction or healthy people, or both groups. One of the notable features of these programs is that they are computer-based programs. The participant performs brain/cognitive exercises on a computer. The exercises help the participant to actively use cognitive processing strategies. Several studies have examined whether these cognitive training programs are effective for various populations. These studies have commonly found that cognitive training has positive effects on cognitive processing (Bergman et al., 2011; Holmes, Gathercole, &Dunning, 2009; Klauer & Willmess, 2002; Klauer & Phye, 2008; Klingberg, 2010; Jaeggi et al., 2011; Mahncke et al., 2006; Rueda, Checa, &Cómbita, 2012; Roughan & Hadwin, 2011; Owen et al., 2010; Smith et al., 2009; Tachibana et al., 2012). However, some authors have suggested that the findings are not sufficient to demonstrate that cognitive training programs are effective (Melby-Lervåg & Hulme, 2012; Shistead, Redick, &Engle, 2012).

In a study in which cognitive training was performed with healthy participants, it was observed that cognitive training led to performance gains in visual-spatial working memory tasks and reasoning tasks,and that this effect has continued as revealed by the measurements carried out eight months after the training was over. It was found in the same study thatcognitive training resulted in an increased activation in the pre-frontal region (Westerberg & Klingberg, 2007). In another study which examined the impact of cognitive training on the working memory performance of participants with ADHD, it was found that treatment with medication led to an increase in visual-spatial working memory, while cognitive training caused an increase both in visual-spatial and in verbal working memory (Holmes et al., 2009). Furthermore, a study carried out by Klinberg et al. (2005) revealed that the more the intensity of the cognitive training increases, the more the capacity of the working memory increases as well as the reasoning ability. Another study, which showed that cognitive training increases working memory, further revealed that when cognitive training is applied to students with limited working memory capacity, their working memory capacity increases,and their academic achievement, particularly in mathematics, also improves as revealed by the measurements carried out in the following six months (Holmes, Gathercole, &Dunning, 2009).

The IQ Up Cognitive Development Method is a program which provides cognitive training that is adaptive to the individual differences of participants. It was developed from the basic theories and applications of cognitive psychology and neuropsychology to aid healthy individuals in the effective and proper use of strategies to improve cognitive processes such as memory, attention, working memory, reasoning, problem solving, mental elasticity, decision making, imaging, analytic thinking, and language. The Cognitive Development Method consists of a training process designed to aid the cognitive development of individuals by considering individual differences, continuously monitoring cognitive development, and facilitating long-term improvements in skills. The most notable feature of the program is that the participants perform the exercises with a trainer one-on-one.

The purpose of the current study is to test whether the Cognitive Development Method, which has been developed based on the theories and applications of cognitive psychology and neuropsychology, improves the cognitive processing and facilitates the cognitive development of healthy children in the target age group. The development of cognitive functioning was examined using pre- and post-tests before and after the training in the IQ Up Cognitive Development Method. To determine the efficacy of the IQ Up Cognitive Training Program, a control group equivalent to the experimental group was also included. Neuropsychological tests were carried out to determine whether there was an improvement in the cognitive function of the participants. These tests included the Wechsler Intelligence Scale For Children-Revised (WISC-R) arithmetic sub-test to measure verbal comprehension and arithmetic abilities; the Wechsler Adult Intelligence Scale-Revised (WAIS-R) symbol sub-test to test focused and continuous attention and visual

perceptional motor comprehension; the Serial Digit Learning Test (SDLT) to measure verbal memory and learning processes; the Öktem Verbal Memory Processes Test (Öktem-VMPT) to measure short and long term verbal memory; the Rey Complex Figure Test and Recognition Trial (RCFT-R) to measure the momentary memory, short- and long-term visual memory and recognition; the Raven Progressive Matrices Test (RSPM) to test problem solving, reasoning, abstract thinking, working memory and general abilities; and the Tower of London (TOL) to measure planning and strategy formulation.

Method

Participants

Two hundred and one healthy children participated in the study. There were 130 participants in the experimental group with an average age of 10.83 (0.44) years. Sixty-nine participants were male (53.1%), while 61 were female (46.9%), and 90.8% of the participants were right-handed. In the control group, there were 71 participants. The average age of the participants was 10.52 (1.41) years. There were 40 males (56.3%) and 31 females (43.7%) in the control group, and 90.2% of the participants in the control group were right-handed. Approval to conduct the study was received from the Social Sciences Research Ethics Committee of Abant İzzet Baysal University. In addition, the parents of the participants were informed about the content of the study, and with their consent, the children were included in the study.

The participants of the study are composed of students attending two schools that are equal to each other in terms of demographic characteristics. Random sampling was employed to determine the school to serve as the experimental group and the one as the control group.

Materials

Information collection form. Data on participants' demographic characteristics and health conditions (such as whether the participant had any illnesses, or required medicine, or had a visual defect or color differentiation problem) were collected using the Standard Information Collection Form.

Raven standard progressive matrices test. The RSPM, which was developed by Raven, consists of 60 test items in 5 sets, each of which contains 12 items (Raven, 2000; Raven, Raven, &Court, 2000).

Tower of London^{DX}. The TOL^{DX} test consists of two strips of wood that have equal lengths. One of these strips belongs to the participant, while the other belongs to the examiner. There are three wooden pegs on each of the strips of wood. The longest of these pegs can hold three balls, while the one with middle length holds 2 balls, and the shortest one holds one ball. On each strip of wood, there are three balls of different colors: blue, red and green (Atalay & Cinan, 2007; Culbertson & Zillmer, 2005).

Stroop test. Stroop test includes expression of the name of colors which are painted in different colors. The test is composed of fice white papers in 14x21.5 cm. There are lines composed of 4 subjects given randomly. These cards are stimulus substances of test and the reaction participants should give towards these stimuli form the sections of test. Basic points of the test are attained by scoring the sections separately. For the five cards of the test; total duration, error number and points of correction number are assessed. The test measures focued attention, speed of data processing, skill of sustaining the task under destructive effect.

Serial digit learning test. This test was developed by Zangwill in 1943. In the Serial Digit Learning Test, the required number of attempts to correctly repeat a sequence of numbers consisting of 9 digits is measured. In this test, it is possible to use a different number sequences for repeated measurements.

Öktem verbal memory processes test. The test, which consists of 15 perceptible words, was developed by Öktem-Tanör (2011) to measure short- and long-term verbal memory abilities. There are different word lists in three different forms of the test; therefore, in repeated measurements, different word lists are used.

Rey complex figure test and recognition trial. In the current study, the revised version of this test by Meyers and Meyers (1995) was used. The RCFT-R consists of 4 stages and measures momentary memory, short- and long-term visual memory, and recognition abilities (Varan, Tanör& Gürvit, 2007).

WISC-R arithmetic sub-test. In this sub-test of the WISC-R, participants are asked to respond to 18 arithmetic problems by performing mental calculations in the shortest time possible. There is a time limit for each problem. If a participant answers incorrectly four times in succession, the test is terminated. The participant receives 1 point for each correct answer (Savaşır & Şahin, 1995; Wechsler, 1974).

WAIS-R symbol sub-test. In the registration form of this sub-test, each number from 1 to 9 is marked with a different sign (for example, a short perpendicular line or two short lines, one over the other). While there is a number on each of the boxes on the registration form, the underside is left blank to be filled in by the respondent. The task of the respondent is to draw the sign corresponding to each number in the box below the number in 90 seconds. At the end of the time, 1 point is awarded for each correct sign (Baştuğ, 2000; Yargıcı, 2000; Yılmaz, 2000; Wechsler,1981).

Cognitive development method. The materials for the Cognitive Development Method were prepared specifically to develop cognitive processing in individuals, and each of the items requires cognitive processing. IQ Up Cognitive Development Method, which is also called Cognitive Training Method, was developed by Clinical Psychologist Zafer Akıncı(Kafadar, Akıncı & Çakır, 2013a;2013b;2014).No harmful material was used in the design of the test. Each item is targeted to the functions of a local area of the brain and correspondingly, to different cognitive functions. The difficulty level of the cognitive tasks in the materials gradually increases. Cognitive Development Method was developed to improve participants' verbal, numeric and visual memory; verbal, numeric and visual attention; and verbal, numeric and visual reasoning. A verbal text is given to the participants to improve their verbal memory processes. In the cognitive task, the participant must improve the skills of first reading the text and then recalling what is read. The participant must answer the questions related to the text in a certain period of time. In the numeric memory task, the participant is given number sequences in different combinations. The participant is required to give answers to the questions related to those numbers during a specified time period. In the visual memory task, on the other hand, the participant is expected to answer the questions related to the visual stimuli presented in different combinations in a specified time period. Memory tasks aim to improve participants' working memory capacity and the speed of mental processes.

In the numeric attention test, the participant must find the numbers and number sequences indicated in the instructions among mixed numbers in a certain period of time. In the verbal attention task, the participant is required to find the letters in a given text and the differences between two texts in a certain time period. In the visual attention task, on the other hand, the participant is expected to find some certain figures among mixed figures and the differences between two pictures during a specified time period. Through these tasks, such basic features of objects as color, size, direction, and movement must be determined. Attention tasks aim at improving participants' visual-spatial perception, selective attention, reaction speed and rashness.

In the verbal reasoning task, the participant is asked to form meaningful associations between the data in the text in a certain period of time. The participant must reach new data by making some logical inferences from the present data. In the numeric reasoning task, the participant is asked to form meaningful associations between numbers and try to reach the expected results within a specified time period. In this cognitive task, the participant must use the skills of scrutinizing, changing categories, and general ability. In visual reasoning task, the participant is expected to make logical inferences by forming meaningful associations between pictures and shapes in a certain time period. The aim of the reasoning tasks is to improve participants' skills of orderly thinking, mental activity speed, working memory, visualization, and general ability.

The materials used in the IQ Up Cognitive Development Method and the tasks to be performed by the participants using these materials are as follows:

1. There are different colors in the background, in the letter used in imprinting and in the inscription itself. The participant is expected to match the three specified combinations. The aim is to improve participants' visual attention and memory.

2. On a different background color, there are pictures that are similar to each other, identical to each other, or different from each other. The participant is expected to match or remember the pictures with respect to the specified features. The aim is to improve participants' visual attention, memory and reasoning.

3. On a different background color, there are phonologically and semantically similar words. The respondent is expected to match or remember the inscriptions based on the specified features. The aim is to improve participants' verbal attention, memory and reasoning.

4. On a white background, there are specific number combinations. The respondent is expected to match or remember the numbers based on the specified features. The aim is to improve participants' numeric attention, memory and reasoning.

5. There are stimuli made up of 4 numbers and 8 colors. The respondent is expected to answer the question by matching the numbers with the specified colors. The aim is to improve participants' visual memory and reasoning.

6. This item consists of rectangles and squares that are proportional to each other, but in different sizes. The respondent is expected to carry one of the materials from one point to the other among some other materials based on a given rule. The aim is to improve participants' visual reasoning.

7. This item consists of materials with different shapes, colors and sizes. The respondent is expected to choose the material with the specified shape, color, or dimensions to form another meaningful shape from these or to arrange the shapes in accordance with their specified characteristics. The aim is to improve participants' visual attention, memory and reasoning.

8. This item consists of materials with different geometrical shapes and colors. The respondent is expected to form a shape within the specified boundaries with the given materials. While doing this, the participant is also expected to use the materials correctly. The aim is to improve participants' verbal and visual reasoning.

9. This item consists of 28 cards that are different from each other. The respondent is expected to see and maintain the movement of the given cards. The aim is to improve participants' visual attention.

10. This item consists of 32 letters. The letters are upper or lower case, and with respect to size, they are large followed by small or the reverse. The respondent is expected to match the same letters according to a specified order, to remember the letters in detail, or to form some words given in a text with these materials. There are also some other applications, such as forming a combination with other materials or matching the materials with other materials. The aim is to improve participants' verbal attention, memory and reasoning.

11. This item consists of 10 numbers, and with respect to the content and size, the materials are large or small, black or white, and the reverse. The respondent is expected to match the same numbers according to a specified order, to remember the numbers in detail, or to form a combination with other materials or to match the materials with other materials. The aim is to improve participants' numeric attention, memory and reasoning.

12. This item consists of different shapes with different sizes and colors. The respondent is expected to choose the material with the specified shape, color or size, to form another meaningful shape, or to arrange the order of the shapes according to specified features. There are some other applications, such as forming a combination with other materials or matching the materials with other materials. The aim is to improve participants' visual attention, memory and reasoning.

13. This item consists of materials with different colors. The respondent is expected to remember or choose the color according to the meaning given to the color. There are some other applications, such as forming a combination with other materials or matching the materials with other materials. The aim is to improve participants' visual memory, reasoning, and attention.

14. The participant is expected to match the squares containing pictures similar to each other, the same as each other, or different from each other. The respondent is also expected to remember or match the pictures according to the specified content. The aim is to improve participants' visual attention, memory and reasoning.

15. Cards consist of specified letters or numbers. The respondent is expected to find the requested information among all the cards. The aim is to improve participants' verbal and numeric attention.

16. This item consists of sticks with different dimensions. The respondent is expected to use the materials to solve the problems given. The aim is to improve participants' visual and verbal reasoning.

17. Cards consist of information related to daily life, such as a name, a profession, age, a town, food, or an entertainment area. The respondent is expected to remember or find the information on the card in an excerpt of text. The aim is to improve participants' verbal memory and reasoning.

18. This item consists of different place names and aerial view maps. The respondent is expected to find the places on the map based on the data provided in the text and to remember the names of the places in the correct order. The aim is to improve participants' verbal memory and reasoning.

19. This item is a set consisting of a plastic panel, rubber bands, and cards with numeric and verbal content. The application starts by placing the cards on the panel. The respondent is expected to form a shape by using the rubber bands in accordance with the directions. The respondent is also expected to find specific letters or shapes in the picture. The aim is to improve participants' visual attention and memory, and verbal and numeric reasoning.

Procedure

Participants who take part in the training process undergo a series of procedures. At the initial stage, participants take online tests measuring cognitive processes such as attention, memory, problem solving, reasoning, and ratiocination, designed based on the age of the participants. In the evaluation of these test results, the performance of the individual for each cognitive function is expressed in percentage. Following this evaluation, a special booklet is prepared for each of the participants. In this booklet, there are cognitive exercises, which are prepared specifically for each participant based on the age and cognitive potential of the participant. These exercises are performed with a trainer who has already received training. The difficulty level of the exercises varies depending on the age and cognitive potential of the participant. Training sessions continue for 1 to 10 months, 5 days a week, 45 minutes a day with the trainer. In the next stage, each of the participants is administered a test every 30 days to determine whether there is a change in cognitive development. These tests are used to determine the degree to which the cognitive exercises contribute to the cognitive development of the participants, as well as the extent of the increase or decrease in the performance related to each of the cognitive processes. The goal of these cognitive exercises is to help each participant more effectively use cognitive processing strategies (http://www.iqup.com.tr/).

Participants began by filling out the Information Collection Form and completing the neuropsychological tests. Tests were administered at the Üsküdar Municipality Information Houses to each participant in the experimental group. Following the administration of pretests to the participants in the experimental group, participants took the online test. The online test consists of tests that require the use of various cognitive functions such as verbal, numeric and visual attention; verbal, numeric and visual memory; and verbal, numeric and visual reasoning. Following theonline test, the performance of the participant was determined for each cognitive function in percentage. Upon determining each participant's level of cognitive functioning, booklets which described how to perform the cognitive tasks and which enabled the participants to develop their weaker cognitive functions were preparedspecific to each participant. Then, each of the participants started the Cognitive Development Method using their personalized booklets. This training was conducted by trainers who were knowledgeable in the subject matter. Training sessions were conducted in classes with 8-10 participants and one trainer. These sessions lasted 30 business days in total and were conducted 5 days a week for 45 minutes a day for each participant. After the participants in the experimental group completed these training sessions, the neuropsychological tests were re-administered to these participants. In the experimental group, the trainers applying the Cognitive Development Method and the testers applying the neuropsychological tests were not the same people. In the application of pre-test and neuropsychological tests, different test items of the Serial Digit Learning Test and Öktem Verbal Memory Processes Test were used. However, the test items of the other neuropsychological tests used in the study were the same in the experimental and control group pre-test and post-test applications.

Neuropsychological tests were administered to the participants in the control group twice, with an interval of roughly 30-40 days. Neuropsychological testing was performed at İstanbul Bağcılar Municipality Information Houses. The participants in the control group and the experimental group continued their usual daily activities between the pre- and post- neuropsychological tests.

Results

To evaluate the data obtained in this study, arithmetic means, standard deviations, correlations and results fromanalysis of variance (ANOVA) were obtained. The pretest means, posttest means, standard deviations, F values and significance levels for both the experimental and the control groups are presented in

Table 1. Neuropsychological test scores of the participants in the experimental and control group, pre-test and post-test means, standard deviations, F values, and significance levels.

	Pre-Test								Post-Test							
Scores	Experimental Group			Control Group					Experimental Group			Control Group				
	N	M	S.D.	N	M	S.D.	F	p	N	M	S.D.	N	M	S.D.	F	p
WAIS-R Symbol	115	39.51	8,25	70	37,71	9,15	1,9	,17	115	44,26	8,83	70	39,58	8,25	12,84	,000
WISC-R Arithmetic	109	13.11	2.47	71	13.10	2.74	.001	.977	109	14.11	2.14	71	13.18	2.50	7.10	.009
Serial Digit Learning Test	115	14.01	6.54	70	14.89	6.60	.776	.379	115	17.90	4.49	70	12.35	7.55	39.24	.000
Öktem-Verbal Memory Processes	117	114.25	16.75	70	119.44	17.15	4.13	.043	117	126.96	11.59	70	113.48	17.84	39.21	.000
Öktem-Verbal Memory Processes Long Term Memory	102	12.73	2.12	64	12.52	2.00	.402	.527	102	13.00	1.74	64	11.54	2.69	17.82	.000
Rey Complex Figure Copy Test	120	31.92	4.75	69	30.97	6.06	1.40	.238	120	32.94	3.97	69	30.02	5.72	17.02	.000
Rey Complex Figure Test and	117	18.73	7.64	69	16.05	7.48	5.42	.021	117	24.33	6.31	69	19.02	8.79	22.78	.000
Rey Complex Figure Test and	118	19.03	7.87	69	15.95	7.43	6.94	.009	118	23.86	6.54	69	17.89	7.90	31.07	.000
Rey Complex Figure Test and	114	20.30	2.10	68	18.97	2.16	16.77	.000	114	21.11	1.86	68	19.94	1.91	16.32	.000
Stroop-1 Time	117	10.57	3.29	71	10.82	3.17	0.25	.618	117	8.89	1.85	71	10.29	2.07	22.90	.000
Stroop-2 Time	117	11.13	4.25	71	11.45	3.34	.297	.586	117	10.71	3.23	71	12.95	4.08	17.29	.000
Stroop-3 Time	117	15.36	3.32	71	15.85	3.80	.845	.359	117	13.68	2.99	71	14.91	2.78	7.86	.000
Stroop-4 Time	117	23.57	6.30	71	23.97	5.79	.188	.665	117	18.64	4.04	71	20.25	3.97	7.12	.008
Stroop-5 Time	117	33.54	11.52	71	35.66	9.00	1.75	.186	117	26.45	7.48	71	31.50	7.62	19.86	.000
Tower of London Total Correct	113	2.53	1.91	65	2.38	2.05	.228	.634	113	2.95	2.13	65	2.12	1.86	6.88	.009
Tower of London Total Move	113	47.60	18.25	65	50.66	22.17	.988	.321	113	43.20	18.48	65	49.29	20.49	4.13	.044
Tower of London Total Initiation	113	30.05	40.24	65	32.37	32.84	.154	.695	113	32.77	34.50	65	22.47	24.37	4.49	.035
Tower of London Total Rule	113	1.15	1.54	65	1.62	2.46	2.39	.124	113	.16	.39	65	.43	1.18	4.64	.032
Raven Standard Progressive Matrices Total Score	103	37.66	8.49	44	36.20	10.89	.761	.385	103	41.18	7.98	44	33.70	10.95	21.44	.000
Raven Standard Progressive	103	30.56	8.27	44	26.29	7.73	8.54	.004	103	28.31	8.51	44	19.14	6.49	40.73	.000

Table 1. From the data, it is apparent that the means of the experimental group are higher than those of the control group. While pretest F values show that neuropsychological test results are not meaningfully different between the experimental and the control groups, the posttest F values are significantly different between the groups. In other words, the IQ Up Cognitive Development Method was effective for the

participants in the experimental group and had a positive impact, increasing their cognitive development. On the other hand, no change was observed in the cognitive development of the control group participants, who did not attend the IQ Up Cognitive Development Method. Moreover, for the control group, a decrease was observed in the mean for the neuropsychological posttest compared to the neuropsychological pretest (for example, on RSPM Total Points) (see Table 1).

Table 2. Correlation values indicating the online cognitive test scores of the participants prior to the Cognitive Training Program (N= 114).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1)Verbal Memory-1	1								
(2)Numerical Memory-2	.163	1							
(3)Visual Memory-3	-	,02	1						
(4) Verbal Attention -1	-	-	-	1					
(5) Numerical Attention - 2	.056	.02	.029	.167	1				
(6) Visual Attention t -3	.097	-	-	.333	.119	1			
(7) Verbal Reasoning- 1	.490	.06	.054	-	.240	-	1		
(8) Numerical Reasoning - 2	.236	.14	.080	-	.063	-	.353	1	
(9) Visual Reasoning -3	.258	.12	.133	.026	.199	-	.398	.20	1

As mentioned previously, the participants in the experimental group took the online cognitive tests prior to the IQ UpCognitive Development Method to determine their cognitive processing ability related to the tested cognitive functions. In Table 2, the correlation values for these cognitive test results are presented for the participants in the experimental group. In other words, Table 2 presents the cognitive performance level of the participants related to the cognitive exercises. These cognitive tests were developed to evaluate the verbal, numeric and visual memory; attention; and reasoning skills of the participants. The correlations between verbal memory and the reasoning exercises, between verbal attention and visual attention, and among all the reasoning exercises are significant (see Table 2).

Table 3 shows the correlation between the Cognitive Development Method results (presented in Table 2) and the neuropsychological test results. The correlation coefficients were calculatedto determine whether Cognitive Test results were consistent with neuropsychological test results.The Cognitive Test results for the verbal, numeric, visual memory; attention; and reasoning presented in Table 2 are grouped into three categories (memory, attention and reasoning), and the total scores for these three categories were obtained. The coefficients presented in Table 3 are the correlation values between the pretest scores of the participants in the experimental group and their Cognitive Test results. When these correlation values are examined, the total score for memory correlated with the scores for arithmetic, Stroop 4 time and Öktem-VMPT, and the total score for attention correlated with the Stroop 3 and Stroop 4 error scores. Moreover, the total score for reasoning correlated with the Symbol subtest score; the Stroop 3, 4 and 5 time scores; the Stroop 5 error score; all the Öktem-VMPT scores; the Tower of London run-time; and the total RSPM score.

Table-3 Correlation between cognitive test scores and pre-test neuropsychological test scores for the participants in the experimental group (N= 114).

Pre-Test Neuropsychological Scores of Experimental Group	Memory Total	Attention Total	Reasoning Total
Symbol	.003	.405	.411**
SDLT	-.092	-.106	-.076
Arithmetic	.241*	.186	.488**
Stroop-1 Time	-.123	.074	-.286**
Stroop-2 Time	-.037	-.016	-.185
Stroop-3 Time	-.096	-.057	-.285**
Stroop-3 Error Score	.054	-.201*	.069
Stroop-4 Time	-.229*	.089	-.308**
Stroop-4 Error Score	.023	-.218*	.015
Stroop-5 Time	-.150	-.009	-.331**
Stroop-5 Error Score	-.116	-.073	-.282**
Öktem VMPT Immediate Recall	.076	.104	.182
Öktem VMPT SBST Total Learning	.227*	.103	.245**
Öktem VMPT Highest Learning	.246**	.107	.258**
Öktem VMPT Long Term Memory	.279**	.094	.331**
Öktem VMPT Recognition	-.293**	-.148	-.298**
RCFT-R Copy	.133	.023	.171
RCFT-R Immediate Recall	.195	-.052	-.015
RCFT-R Delayed Recall	.200*	.012	.048
RCFT-R Recognition	.133	.177	-.027
TOL Total Correct Score	-.032	.099	-.004
TOL Total Move Score	-.057	-.004	-.062
TOL Initiation Time	-.064	.013	.057
TOL Execution Time	-.003	-.271**	-.215*
TOL Total Time	-.021	-.250**	-.185
TOL Total Rule Violations	.035	-.220*	-.172
RSPM Total Score	.090	.157	.420**
RSPM Time	-.013	.049	.094

Discussion

This study was conducted to test whether the IQ Up Cognitive Development Method contributes to the cognitive development of healthy school-age children. To this end, neuropsychological tests were administered to 201 children in both the experimental and the control groups by means of pretest and posttest. The data obtained were examined using multivariate statistical analysis. The results reveal that there is no meaningful difference in the pretest performance between the experimental group and the control group. Yet, there is a significant difference in their posttest performances. This difference is evident in the mean neuropsychological test scores of the groups. This result is consistent with other empirical research showing that various cognitive training programs positively contribute to the cognitive development of

healthy participants (Brehmer, Westerberg,& Backman, 2012; Olesen, Westerberg,& Klingberg, 2004; Thorell et al., 2009; Roughan & Hadwin, 2011). According to a research study, elementary school students whose inductive reasoning skills were improved through cognitive education have an improved performance in quick intelligence, and consequently an increase in academic success. According to the researchers, cognitive education that students receive leads to an improvement in their problem solving skills (Klauer & Phye, 2008).

The students who received cognitive education with Cognitive Development Method also made progress in the processes of working memory, attention and reasoning. The increase in the post-test neuropsychological test scores of the participants in the experimental group supports this finding. Particularly, the increase in RSPM and Tower of London test scores made it possible to achieve an improvement in experimental group participants' such cognitive processes as problem solving, planning, strategy development and mental processing speed. The same situation is observed in the scores of pre- and post-test SDLT, Öktem-VMPT, and RCFT-R, which measure the verbal and visual memory processes of the participants in the experimental group. In other words, there is an improvement in participants' memory processes. Moreover, as expected in Stroop test time scores, a decrease was observed in post-test scores. Accordingly, there was an increase in the attention processes and reaction speed of the participants in the experimental group. It is believed that the individual application of the Cognitive Development Method for each participant had a positive impact on research results.

To determine in which cognitive processes and to what extent the Cognitive Development Method promotes development, participants in this study were administered in-depth neuropsychological tests that measure cognitive processes such as attention, memory, problem solving, planning, strategy formation, arithmetic, and working memory. The results of the statistical analysis also show that the Cognitive Development Method, which was conducted for 45 minutes a day, 5 days a week for 30 days in total, positively contributed to the cognitive processing of the participants in the experimental group. The results also reveal that there is a meaningful relationship between the scores obtained in cognitive exercises performed by the participants during IQ Up Cognitive Development Method and the results of the neuropsychological tests. This finding also supports the existence of a relationship between the cognitive exercises performed within the scope of the Cognitive Development Method and the neuropsychological test results and, hence, various other cognitive processes. This finding is consistent with the findings of similar studies conducted on healthy children (Brehmer, Westerberg,& Backman, 2012; Jaeggi et al., 2011; Olesen, Westerberg, &Klinberg, 2004).

For the control group participants, scores on the Serial Digit Learning Test, Verbal Memory and Learning Processes Test and the Raven Standard Progressive Matrices Test decreased from the pretest to the posttest. This decrease may have resulted, in part, from the proximity of the posttest to a school vacation. Thus, the participants' neuropsychological testing occurred at a time when participants were less mentally active. On the other hand, scores for Symbol, Arithmetic, Rey Complex Figure test and the Tower of London increased from the pretest to the posttest. The Stroop Test, a test of reaction time, also decreased from the pretest to the posttest.

The Cognitive Development Method can reduce the likelihood of academic failure resulting from poor performance (forgetfulness, inattentiveness, disorganization, attention deficiency, etc.) in cognitive processes, especially for school-age children. The most important characteristic of the program is that it encourages active participation in the training program, increasing the activation of mental processes.

The materials for the cognitive exercises developed in the program are given to the participant, and the participant performs cognitive exercises with these materials in the company of a trainer. The Cognitive Development Method is not a computer-based program; instead, the efforts of participants to perform the cognitive exercises with the materials given to them increase the effectiveness of the program. Therefore, participants may achieve substantial improvement in cognitive processing, and participants may be better-equipped to deal with problems that require increasingly greater cognitive functioning. The Cognitive Development Method is different, in this respect, from similar brain/cognitive training methods.

Another notable characteristic of the Cognitive Development Method is that it improves performance related to cognitive processes that are not well developed in the participant. The main aim of the Cognitive

Development Method is to improve performance in the weaker cognitive processes of the participant. The cognitive exercises that were performed by the participants were selected with this objective. However, these findings show that in addition to the cognitive processes of the participant that were expected to improve, other cognitive processes of the participant improved as well. This finding is important because it shows that cognitive processes have a very close relationship with each other, which may be related to the presence of neural networks in the brain (Kafadar, 2004a;2004b;2012a;2012b).

The benefits of cognitive training programs are not limited to healthy people. It is particularly crucial to examine whether these programs are effective as a treatment method for children and adults with attention deficit disorders, hyperactivity disorders, learning difficulty, dyslexia, autism, head trauma, mild cognitive disorders, dementia and other similar neurological and psychiatric disorders. Some computer-based cognitive training programs have demonstrated a treatment effect for people with these cognitive dysfunctions (Beck et al., 2010; Dahlin, 2011; Gibson et al., 2011; Holmes et al., 2009; Van der Molen et al., 2010). It is necessary to examine whether the Cognitive Development Method is a potential treatment method for conditions involving cognitive impairment. In addition, in future studies, it will be necessary to determine whether there are changes in the social behaviors and emotional processes of the participants and whether theIQ Up Cognitive Development Method contributes to the personality development of children. In light of this possibility, whether the Cognitive Development Method causes molecular and neural changes in the brain should be further examined with neurological studies.

Despite its benefits and potential, the study has some limitations as well. First, the IQ Up Cognitive Development Method should be tested on different age groups. Secondly, whether cognitive training is effective should be examined through different measures apart from the neuropsychological tests (for example academic success).

Acknowledgements

We, the authors of present research, would like to express our sincere thanks to Betül Akıncı, Merve Kılıç, Janin Marazyan, Havva Yıldırım, Kısmet Güler, Havva Çelik, Selena Güdücü, and Pınar Erçelik for their valuable contributions in the application of neuropsychological tests.

References

Atalay, D. and Cinan, S. (2007). Planning ability of adults: Standardization and reliability of TOL^{DX}*Turkish Psychology Journal* 22, 25-38.

Baştuğ, B. (2000). *Pilot study on the performance subtest of Wechsler Adult Intelligence Scale-Revised (WAIS-R)* . Unpublished master thesis, Ankara University.

Beck, S. J., Hanson, C. A., Puffenberger, S. S., Benninger, K. L. and Benniger, W. B. (2010). A controlled trial of working memory training for children andadolescents with ADHD. *Journal of Clinical Child and Adolescent Psychology, 39,* 825–836. doi:http://dx.doi:10.1080/15374416.2010.517162

Bergman, S.N., Söderqvist, S., Bryde, S., Thorell, L.B., Humphreys, K. and Klingberg, T. (2011). Gains in fluid intelligence after training non-verbal reasoning in 4-year-old children: A controlled, randomized study. *Developmental Science 14:3, 591–601.* doi: 10.1111/j.1467-7687.2010.01022.x

Bracy, O. L. (1994). Cognitive functioning and rehabilitation*: Journal of Cognitive Rehabilitation,* 12, 12-16.

Brehmer, Y., Westerberg, H. and Backman, L. (2012). Working-memory training in younger and older adults: Training gains, transfer, and maintenance. *Frontiers in Human Neuroscience,* 6(63), doi: 10.3389/fnhum.2012.00063

Culbertson, W.C. and Zillmer E.A. (2005). *Tower of London Drexel University* (2nd Ed.) Toronto: Multi-Health Systems.

Dahlin, K. I. E. (2011). Effects of working memory training on reading inchildren with special needs. *Reading and Writing,* 24, 479–491. http://dx.doi: 10.1007/s11145-010-9238-y

Gedikoğlu, T. (2005).The European Union is in the process of the Turkish education system: Problems and solution recommendations. *Journal of Mersin University Faculty of Education* 1, 66-79.

Gibson, B. S., Gondoli, D. M., Johnson, A. C., Steeger, C. M., Dobrzenski,B. A., & Morrissey, R. A. (2011). Component analysis of verbal versusspatial working memory training in adolescents with ADHD: A randomized,controlled trial. *Child Neuropsychology*,17:6,546-63. doi: 10.1080/09297049.2010.551186

Holmes, J., Gathercole, S. E., Place, M., Dunning, D. L., Hilton, K. A., and Elliott, J. G. (2009). Working memory deficits can be overcome: Impacts of training and medication on working memory in children with ADHD. *Applied Cognitive Psychology*, 24, 827–836. doi: 10.1002/acp.1589

Holmes, J., Gathercole, S.E. and Dunning, D.L. (2009).Adaptive training leads to sustained enhancement of poor working memory in children. *Developmental Science* 12:4, 9-15. doi: 10.1111/j.1467-7687.2009.00848.x

Kafadar, H., Akıncı, Z. and Çakır, B. (2014). Long-term effect of IQ Up Cognitive Development Method on the development of cognitive process in children. *American International Journal of Social Science*,3:4.

Kafadar, H. , Akıncı, Z. and Çakır, B. (2013a). *Effects of the IQ Up Cognitive Training Program on the cognitive development of 10- to 12-year-old children.*Fifth International Congress of Educational Research, 6-9 June, 2013 Çanakkale Onsekiz Mart University .

Kafadar, H., Akıncı, Z. and Çakır, B. (2013b). Effects of the IQ Up Cognitive Development Method's on the cognitive improve.*Journal of the International Neuropsychological Society*, 19 :S2. doi: http://dx.doi:org/10.1017/S1355617713001033

Kafadar, H. (2012a). Mental flexibility, reasoning, focused attention, planning and fluid intelligence: A latent variable approach. *Journal of the International Neuropsychological Society*, 18(2). doi:http://dx.doi:org/10.1017/S1355617712001063

Kafadar, H. (2012b). Cognitive model of problem solving. *New Symposium* 50(4), 195-206.

Kafadar, H. (2004a). *Prediction of fluid intelligence through performance intelligence, verbal intelligence, executive functions, working memory, selective attention and short term memory processes.* Unpublished doctorate thesis, Ankara: Hacettepe University.

Kafadar, H. (2004b).Between intelligence and cognitive processes relationship. *3P Journal* 12(3), 171-190.

Klauer, K.J. and Wilmess, K. (2002).Inducing inductive reasoning:Does it transfer to fluid intelligence. *Contemporary Educational Psychology*, 27, 1-25. doi:10.1006/ceps. 2001.1079

Klauer, K.J.and Phye G.D. (2008). Inductive reasoning: A training approach . *Review of Educational Research*, 78(1) 85-123.

Klinberg, T., Fernell, E., Olesen, P., Johnson, M., Gustafsonsson,P., Dahlström, K., and coll. (2005). Computerized training of working memory in children with ADHD-a randomized, controlled trial. *Journal of the American Academy of Child and Adolescent Psychiatry*, 44(2), 177-186. doi:10.1097/00004583-200502000-00010

Klingberg, T. (2010). Training and plasticity of working memory. *Trends in Cognitive Sciences*, 14(7), 317–324, doi 10.1016/j.tics.2010.05.002

Jaeggi, S. M., Buschkuehl, M., Jonides, J. and Shah, P. (2011). Short and long-term benefits of cognitive training. *Proceedings of the NationalAcademy of Sciences of the United States of America (PNAS)*, 108(25), 10081–10086. doi: 10.1073/pnas.1103228108

Mahncke ,H.W., Connor, B.B., Appelman, J., Ahsanuddin, O. N., and coll.(2006). Memory enhancement in healthy older adults usinga brain plasticity-based training program: A randomized, controlled study. *Proceeding of the National Academy of Sciences of the United State America (PNAS)* 103(33), 12523 – 12528. doi:10.1073/pnas.0605194103

Melby-Lervåg, M. and Hulme, C. (2012). Is working memory training effective? A meta-analytic review. *Developmental Psychology*, 49(2), 270-291. doi:10.1037/a0028228

Meyers, J.E. and Meyers, K.R. (1995). *Rey complex figure test and recognition trial.* Florida: Psychological Assessment Resources.

Raven, J. (2000). The Raven's Progressive Matrices: Change and stability over culture and time. *Cognitive Psychology, 51*, 1-48.

Raven, J., Raven, C. and Court, J.H. (2000). *Raven manual: section 3. standard progressive matrices*. San Antonio, Texas: Harcourt Assessment.

Roughan, L. and Hadwin, J. A. (2011) .The impact of working memory training in young people with social, emotional and behavioural difficulties. *Learning and Individual Differences*, 21(6) 759-764. doi:10.1016/j.lindif.2011.07.011

Rueda, M. R., Checa, P. and Cómbita, L. M. (2012). Enhanced efficiency of the executive attention network after training in preschool children: Immediate changes and effects after two months. *Developmental Cognitive Neuroscience*, 15(2), 192-204. doi: 10.1016/j.dcn.2011.09.004

Olesen, P., Westerberg, H. and Klingberg, T. (2004). Increased prefontal and parietal activity after training of working memory . *Nature Neuroscience,* 7(1), 75-79. doi:10.1038/nn1165

Owen, A. M., Hampshire, A., Grahn, J. A., Stenton, R., Dajani, S., Burns,A. S., Howard, R.J. and Ballard, C. G. (2010). Putting brain training to the test. *Nature,* 465:7299, 775–778. doi: 10.1038/nature09042.

Savaşır, I. and Şahin, N. (1995). *Wechsler For Children Intelligent Scale-Revised (WISC-R) Manuel book.* Ankara: Turkish Psychologist Society Publish.

Smith, G.E., Housen, P., Yaffe, K., Ruff, R., Kennison, R.F., Mahncke, H.W. and Zelinski, E.M. (2009). A cognitive training program based on principles of brain plasticity: Results from the Improvement in Memory with Plasticity-based Adaptive Cognitive Training (IMPACT) study.*J Am Geriatr Soc.*,57(4), 594-603. doi: 10.1111/j.1532-5415.2008.02167.x

Sternberg, R. J. (2008). Increasing fluid intelligence is possible after all. *Proceeding of the National Academy of Sciences of the United State America (PNAS)* 105(19) 6791– 6792. doi:10.1073pnas.0803396105

Shipstead, Z., Hicks ,K.L. and Engle, R. W. (2011). Cogmed working memory training: Does the evidence support the claims? *Journal of Applied Research in Memory and Cognition,*1(3), 185–193. doi: 10.1016/j.jarmac.2012.06.003

Tachibana, Y., Yoshida, J., Ichinomiya, M., Nouchi, R., Miyauchi, C., Takeuchi, H., Tomita, N., Araj, H. and Kawashima, R. (2012). A GO intervention program for enhancing elementary school children's cognitive functions and control abilities of emotion and behavior: Study protocol for a randomized controlled trial. *Trials,* 13, 1-8. doi:10.1186/1745-6215-13-8

Öktem-Tanör. Ö. (2011). *Öktem Verbal Memory Processes Test (ÖKTEM-VMPT) Manuel book*. Ankara: Turkish Psychologist Society Publish.

Thorell, L.B., Lindqvist, S., Bergman Nutley, S., Bohlin, G. and Klingberg, T. (2009), Training and transfer effects of executive functions in preschool children .*Developmental Science 12(1),* 106-113. doi: 10.1111/j.1467-7687.2008.00745.x

Varan, E., Tanör, Ö. and Gürvit, H. (2007). Rey complex figure test-recognition trial: Norm determination study on turkish adult sample. *Journal of Turkish Neurology,* 13, 387-394.

Van der Molen, M. J., Van Luit, J. E. H., Van der Molen, M. W., Klugkist, I., and Jongmans, M. J. (2010). Effectiveness of a computerised working memory training in adolescents with mild to borderline intellectual disabilities. *Journal of Intellectual Disability Research, 54(5),* 433–447. doi: 10.1111/j.1365-2788.2010.01285.x

Yargıcı, S. (2000). *Pilot study on the performance subtest of Wechsler Adult Intelligence Scale-Revised (WAIS-R).* Unpublished master thesis, Ankara University.

Yılmaz, B. (2000). *Pilot study on the vocabulary subtest of Wechsler Adult Intelligence Scale-Revised (WAIS-R).* Unpublished master thesis, Ankara University.

Wechsler, D. (1974). *Manual for the wechsler ıntelligence scale for children—revised.* New York: Psychological Corporation.

Westerberg, H. and Klinberg, T. (2007). Changes in cortical activity after training of working memory - a single-subjectanalysis. *Psysiology&Behaviour, 92*(1-2), 186-192. doi:10.1016/j.physbeh.2007.05.041

Wechsler, D. (1981). *Wechsler Adult Intelligence Scale—Revised Manual.* New York: Psychological Corporation.

Zangwill, O.L. (1943). Clinical tests of memory impairment. *Proceedings of Royal Society of Medicine,* 36, 576-580.