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The Effect of Cognitive Flexibility Training on Reduction of Cognitive Problems in Adolescents with Intellectual Disabilities

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Abstract

***Background*:** Children and adolescents with intellectual disabilities are the most challenging groups of individuals among exceptional people. In this regard, the main responsibility lies with the parents, tutors, psychologists, and nurses. The present study aimed to evaluate the effect of cognitive flexibility training on reducing cognitive problems in adolescents with intellectual disabilities.

***Methods*:** The present quasi-experimental study used a pretest-posttest design with a control group. The participants included 40 female students aged 13-18 years who attended special schools in the city of Shiraz, Iran. Data were collected using the Wisconsin Card Scoring Test (WCST) and the Test for Severe Impairment (TSI). The data were analyzed through SPSS software (version 18.0), using descriptive statistics and inferential statistics of covariance analysis.

***Results*:** After moderating the pretest scores, cognitive flexibility training showed to have a significant effect ($P<0.05$) on reduction of cognitive impairment. The effect of cognitive flexibility training on reducing cognitive impairment was 70.2%. Moreover, the training used also had a significant effect ($P<0.05$) on reduction of motor impairment, language comprehension impairment, language processing, memory impairment, and general knowledge by 33.7%, 10.4%, 14.8%, 28.6%, and 11%, respectively. The results showed that the cognitive flexibility training did not have a significant effect ($P>0.05$) on reduction of impairment in abstract conceptualization.

***Conclusion*:** It was revealed that 13-18-year-old adolescents with intellectual disabilities who attended a total of 15 training sessions had fewer cognitive problems such as motor function, language comprehension, language processing, memory, and general knowledge.

***Keywords*:** Adolescent, Cognitive, Education, Flexibility, Intellectual Disability

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Introduction

Intellectual disability is defined as a widespread neurodevelopmental disorder which affects children's functional behavior in early life (1-3) and includes disorders such as autism spectrum disorder, overall developmental delay (children <7 years), mental disability (children >7 years), physical disability, sensory disability (hearing or vision), and speech disability (4, 5). Children and adolescents with intellectual disabilities are the most challenging group of individuals among exceptional people and it is necessary to consider their cognitive characteristics, abilities, mental constraints, and learning capacities; implement effective educational methods; and determine the quality and quantity of educational materials. In this regard, the main responsibility lies with the parents, tutors, psychologists, and nurses (6).

The main cognitive characteristics of people with Intellectual and Developmental Disabilities (IDD) include clear dysfunction of the cognitive functioning in acquiring knowledge, reasoning and symbolic representation, perceptual reasoning, active working memory and processing speed, along with problems in learning and acquisition of scientific knowledge (7).

Due to the cognitive deficiencies in children with intellectual disabilities and the role of mental abilities (e.g. problem-solving skills and effective decision-making) in academic achievement, specific training on mental abilities is crucial (8). The National Institutes of Health (NIH) in the United States, then, recommends the use of cognitive or neuropsychological rehabilitation based on cognitive-behavioral approach to increase an individual's ability to process and interpret information and get empowered in all aspects of the social and family life (6, 9, 10).

The main goal of this training is to encourage a flexible thinking approach in adolescents with intellectual disabilities and to encourage them to resort to alternative reasoning, avoid stressful and challenging situations, and improve psychological resilience (11, 12). To improve cognitive flexibility, the training enhances the ability of an individual to adjust behavioral patterns and learn from past experiences when faced with a change in his/her environment (13).

Moreover, flexibility influences the environmental changes by affecting the potential learning ability and information analysis of an individual (14). Additionally, inflexibility impairs the functioning by affecting the working memory. The results of various studies have shown that cognitive skills for executive functions can be predictive and contribute to adaptive behavior (15, 16). In addition, various studies have shown the effectiveness of cognitive flexibility training in treating behavioral and cognitive disorders. Based on their results, cognitive flexibility is associated with an individual's ability in producing a sustained response, timely cessation of behavior, and management of emotional responses (17, 18).

Many studies, with satisfactory outcomes, have been conducted in Iran on the effectiveness of the cognitive flexibility training in reducing behavioral problems in children with autism (1, 19) and improving speech in children and adolescents with a stutter (20). Furthermore, nowadays, there is an emphasis on the cognitive and self-control problems in the curriculum for students with intellectual disabilities (8). Moreover, the tutors of exceptional children, in addition to showing empathy, must be able to guide these students to improve their cognitive and behavioral problem-solving skills. In Iran, there is a lack of research on the effectiveness of cognitive flexibility training for people with intellectual

disabilities. In view of the cognitive and behavioral problems in such clinical groups, an obvious need for pertinent research was observed. Hence, the present study aimed to investigate and better determine the effect of cognitive flexibility training in adolescents with intellectual disabilities.

MATERIALS AND METHODS

Study design and population

The present quasi-experimental study was of a pretest-posttest control group design. The sample population included female students aged 13-18 years who attended 3 special middle and high schools in district 4 of Shiraz city, Iran in 2017-2018 academic year.

Based on the purposive sampling used, 40 individuals were selected in accordance with the inclusion and exclusion criteria. The samples were randomly assigned into two groups of experiment and control, each containing 20 students

The inclusion criteria were age range of 13-18 years, intellectually educable individuals, and lack of any sensory-motor impairment. The exclusion criteria were any other prominent disorders except for an intellectual disability, physical illnesses, and a maximum of 3 times being absent in the training sessions. In both groups, the age and educational level of the parents were similar, indicating homogeneity of these variables.

Data Analyses

Data were analyzed using the SPSS software (version 18.0). The Levine's test was used to examine if the groups had equal variances. In addition, the Kolmogorov-Smirnov test (K-S) was used to examine the homogeneity of the variables. To examine the homogeneity of the coefficients (slope), we used a two-way General Linear Model (GLM) with univariate procedure and dispersion pattern. A $P>0.05$ was considered statistically significant for all variables. Descriptive (mean, standard deviation) and inferential statistics of covariance analysis were used to analyze the data.

Research Instruments

- Wisconsin Card Sorting Test (WCST)

For the purpose of the present study, WCST was used, which is a neurological test. It measures abstract reasoning, cognitive flexibility, inhibitory functioning, problem-solving ability, concept formation, a shift in attention, ability to test a hypothesis and the use of feedback errors, the strategy of starting and stopping actions, and maintaining focus was used. WCST examines the role of executive functions related to the frontal lobe and parietal lobe of the brain(21).

In this test, the participants were asked to sort each of the 128 cards with one of the 4 key cards according to color, shape, or number. Based on the Psychology Experiment Building Language (PEBL) software feedback, the participants had to learn from previous mistakes and deduce the correct sorting criteria. To analyze the results, we used categories which involved the appropriate categorization, ranging from 1-6. The test will stop when the adolescent can categorize six items. A typical score for the analysis of WSCT variables was reported as: the number of categories (-0.87), trials to complete the first category (0.21), total errors (0.97), perseverative responses (0.92), perseverative errors (0.93), non-perseverative errors (0.80), and correct responses (-0.94). The reliability of the test has been reported 83% by Strauss and Spreen, while it has been estimated 85% in Iran (22-23).

- Test for Severe Impairment (TSI)

The TSI questionnaire was designed by Jacobs et al. (1999) for the assessment of patients with severe cognitive impairment. In the present study, the TSI was used to assess cognitive impairments of the students attending the special schools across the city of Shiraz. The questionnaire assessed their abilities through correct/incorrect responses and included 24 items on language, memory, conceptual ability, and spatial skills. The six subsections of the TSI questionnaire included over-learned motor skills, language comprehension, language production, immediate/delayed memory, and general knowledge and conceptualization. The reliability of the questionnaire had been confirmed and reported with Cronbach's alpha of 0.89 (24).

Method

In the present study, a 15-session flexibility training program was performed. The instruction in all training sessions was performed by the same person, and each session lasted for 30-45 minutes. The program was designed and developed by Mahaki and Arjomandnia in 2014 (25), based on the educational executive function program by Gottschall and Rozendal in 2011 (26). Attempts were made to enhance the strength of those intellectually disabled students who did not get jaded by repetitive topics. The students actively participated in the training program, the activities were sequenced from simple to more complex tasks, their correct responses were reinforced, and feedback was given. In the designed training program, information regarding the students' aspects of motivation and activities of interest were attended to, when a student correctly performed the assigned task or achieved the goal in a stage. In doing so, their ability to perform different tasks was enhanced and the challenges they faced reduced (**Table 1**).

Table 1: Treatment protocol: Titles, goals, and contents of the training sessions for the experimental group (n=20)

Session	Contents	Goal
1-3	The students are requested to draw up, exhibit, and describe a new plan (not the usual plan) for their free time after school.	Cognitive flexibility ability
4	The students are requested to draw up, exhibit, and describe a plan (not the usual plan) for a day off school.	Cognitive flexibility ability
5	The students are requested to draw up, exhibit, and describe a plan (not the usual plan) for the whole weekend.	Cognitive flexibility ability
6	How do you react to a change and re-plan your daily activities? For instance, if you plan is to watch TV and for some reasons the TV malfunctions or your parents prevent you from watching it. How do you react and what is your alternative?	Mental fitness to adapt
7	How do you react to a change and re-plan your routine activities? For instance, for some reasons you are prevented from using your mobile phone (by parents or school authorities). How do you react and what is your alternative?	Mental fitness to adapt
8	How do you react to a change and re-plan your routine activities? For instance, unlike the usual availability of lunch/dinner, for some reason food is not served.	Mental fitness to adapt

	How do you react and what is your alternative?	
9	How do you react to a change and re-plan your routine activities? For instance, you are playing with the children in the neighborhood after siesta. Your parents request that you stop and return home. How do you react and what is your alternative?	Mental fitness to adapt
10	How do you react to a change and re-plan your daily activities? For instance, how would you fill your time (doing homework or playing a game) if your teacher is absent? Or, you need to return to the classroom due to the cancelation of an outdoor sports lesson. What is your reaction to the above?	Mental fitness to adapt
11	How do you react to a change and re-plan your trip to school? For instance, the driver does not drop you at the usual location or asks a higher fare. How do you react and what is your alternative?	Mental fitness to adapt
12	The students are requested to write down and read out the numbers (2 three-digit numbers, 4 four-digit numbers, and 2 seven-digit numbers). Then, the request is arbitrary changed into other numbers.	Assist cognitive flexibility ability
13	The students are presented with a pack of cards and requested to categorize them according to shape, color, and size.	Assist cognitive flexibility ability
14, 15	A review of the previous sessions and assignments. Each student performs a similar assignment with the help of the coach.	Review of past sessions

Ethical Considerations

In the present study, ethical issues and the participants' rights were of paramount importance. The selection process of the intellectually disabled children was based on random sampling method. Following a full explanation of the methodology and goals of the research provided by the researcher, a written informed consent was obtained from the parents. The parents were fully aware of the required information about their children and how the information was gathered and used. The parents were ensured that the information remained confidential and restrictions on data accessibility by unauthorized staff were emphasized. The study was financially supported and approved by the Research Ethics Committee (number: IR.IAU.DEHAGHAN.REC.1397.004) of Estahban Islamic Azad University, Estahban, Iran.

Results

Descriptive Statistics

The mean score of cognitive impairment and its components (motor impairment, language comprehension impairment, language production impairment, memory impairment, general knowledge impairment, and impairment in abstract conceptualization) in pre-test and post-test stages for both the control and experimental groups are shown in **Table 2**.

Table 2: Mean of Cognitive impairment and its components in pre-test and post-test stages for both the control and experimental groups

Variables (impairment)	Stage	Control group, n=20 Mean ± SD	Experimental group, n=20 Mean ± SD
Cognitive	Pre-test	13.15±2.7	13.75±2.55
	Post-test	11.65±2.58	7.2±2.63
Motor	Pre-test	2.15±0.81	2.05±1.19
	Post-test	2.35±0.99	1.2±1.1
Language comprehension	Pre-test	2.2±0.89	2.1±1.02
	Post-test	2.15±0.93	1.35±1.23
Language production	Pre-test	2.85±0.93	2.25±1.33
	Post-test	2.05±0.94	1.25±0.85
Memory	Pre-test	2.15±0.81	2.55±0.94
	Post-test	1.85±0.93	0.9±0.64
General knowledge	Pre-test	1.8±1.06	2.35±1.18
	Post-test	1.75±1.02	1.0±0.97
Conceptualization	Pre-test	2.0±1.17	2.45±1.91
	Post-test	1.5±0.83	1.5±0.95

Inferential Statistics

The Assumption of Homogeneity of Regression Slope

The results showed the effect of cognitive flexibility training on different variables with the following levels of significance: cognitive disorder ($F_{(1,4)}$=0.088, P=0.985), motor function ($F_{(1,3)}$=0.705, P=0.556), language comprehension ($F_{(1,2)}$=0.116, P=0.89), language production ($F_{(1,3)}$=0.698, P=0.56), memory ($F_{(1,2)}$=0.03, P=0.97), general knowledge ($F_{(1,3)}$=0.384, P=0.766), and conceptualization ($F_{(1,4)}$=0.877, P=0.49).

As shown in **Table 3**, after adjusting for pre-test scores, cognitive flexibility training had a significant effect (70.2%) on the reduction of cognitive impairment ($F_{(1,39)}$=65.81, P<0.05, η^2=0.702). The effect of cognitive flexibility was significant (33.7%) on the reduction of motor function impairment ($F_{(1,39)}$=17.27, P<0.05, η^2=0.337). Also, cognitive flexibility training had a significant effect (10.4%) on the reduction of language comprehension impairment ($F_{(1,39)}$=3.93, P<0.05, η^2=0.104); it also showed a significant effect (14%) on the reduction of language production impairment ($F_{(1,39)}$=5.53, P<0.05, η^2=0.14). Moreover, cognitive flexibility training had a significant effect (28.6%) on the reduction of memory impairment ($F_{(1,39)}$=14.01, P<0.05, η^2=0.286) and the reduction of general knowledge impairment ($F_{(1,39)}$=3.96, P<0.05, η^2=0.11). However, the training had no significant effect on the reduction of impairment in abstract conceptualization ($F_{(1,39)}$=0.069, P<0.05, η^2=0.002) (**Table 4**).

Table 3: The results of normal distribution of the scores (Levine's test) and the homogeneity of variances (Kolmogorov-Smirnov test).

Variables	Levine's test				Kolmogorov-Smirnov test	
	F	df1	df2	P value	Z	P value
Cognitive disorder	1.15	10	29	0.364	0.12	0.18
Motor function	2.34	4	35	0.074	0.09	0.21
Language comprehension	2.15	4	35	0.095	0.081	0.33
Language production	0.848	4	35	0.505	0.13	0.16
Memory	0.461	3	36	0.711	0.043	0.42
General knowledge	3.39	4	35	0.019	0.051	0.39
Conceptualization	2.99	4	35	0.032	0.11	0.19

Table 4: Covariance analysis of the effect of cognitive flexibility training on the reduction of cognitive impairment and its components

Assumption	Source of variation	Sum of products	Degrees of freedom	Mean of products	F	P value	Effect of η^2 coefficient
cognitive impairment	Pre-test	186.85	10	18.68	7.37	0.001	0.725
	Group	166.75	1	166.75	65.81	0.001	0.702
	Error	70.94	28	2.53	-	-	-
Motor Function	Pre-test	23.27	4	5.82	10.7	0.001	0.557
	Group	9.39	1	9.39	17.27	0.001	0.337
	Error	18.48	34	0.544	-	-	-
Language Comprehension	Pre-test	7.43	4	1.86	1.67	0.179	0.165
	Group	4.35	1	4.35	3.92	0.048	0.104
	Error	37.68	34	1.108	-	-	-
Language Production	Pre-test	6.75	4	1.69	2.398	0.069	0.22
	Group	3.89	1	3.89	5.526	0.025	0.14
	Error	23.94	34	0.704	-	-	
memory impairment	Pre-test	2.76	3	0.919	1.49	0.234	0.113
	Group	8.64	1	8.64	14.01	0.001	0.286
	Error	21.59	35	0.617	-	-	-
General Knowledge	Pre-test	7.55	4	1.88	2.126	0.099	0.2
	Group	3.52	1	3.52	3.96	0.046	0.11
	Error	30.19	34	0.89	-	-	-
Abstract conceptualization	Pre-test	6.43	4	1.61	2.317	0.077	0.214
	Group	0.048	1	0.048	0.069	0.794	0.002
	Error	23.57	34	0.693	-	-	-

Discussion

This study aimed at evaluating the effect of cognitive flexibility training on reducing cognitive problems in female adolescents with intellectual disabilities. The results indicated that cognitive flexibility education reduced the cognitive problems of children with intellectual disabilities. Those who participated in a 15-session training program showed a decrease in cognitive problems (i.e. language comprehension, language production, active and delayed memory, and general knowledge). Our findings were in line with those of various previous studies (11, 13, 22, 27, 28, 29, 30, 31, 32, 33, 34, 35). They had all concluded that cognitive flexibility and the corresponding training program positively affected cognitive, behavioral, and psychological problems. Moreover, it reduced cognitive and behavioral problems in different age groups. Hence, it can be concluded that cognitive flexibility training for intellectually disabled adolescents had a positive effect on their ability in dealing with cognitive problems. Since cognitive and behavioral problems stem from the perception of adolescents on these issues, the self-awareness acquired through such training program empowers them to gain a better cognitive insight and subsequently learn to interpret the problems differently and adjust their behavior in an appropriate manner in the case of interpretational conflicts(36). Such awareness allows them to better analyze intellectual and mental issues, understand the intention of others, communicate with people, and recognize and analyze the problems. Moreover, it gives them self-belief and the feeling of competence in managing their own behavior and improves their social interactions. It is worth mentioning that self-belief in adolescents is a supportive factor in resolving cognitive and behavioral problems, which in turn, enhances self-confidence and improves social and academic performance (22, 37).

According to a previous study, child interventions should focus on teamwork to facilitate the engagement of children in daily activities (38). Children are less stressed when they participate in group-based programs (e.g. family-centered), compared to individual interventional programs (39). In the present study, the group-based educational program had a twofold purpose. Not only was it designed to reduce their stress, but also it helped them to exchange experiences and learn from other children through discussions on how to deal with problems. This process can additionally benefit the children in improving their social interaction and reducing cognitive and behavioral problems (40). Group-based sessions can also have a positive effect on the analytical ability of children. By bringing such children together in one group, each child realizes that there are other children with similar problems and learns how others analyze mental issues. Consequently, the child feels less physiological pressure and gets a boost in morale, which leads to a better acceptance of the reality and dealing with problems. Clearly, most cognitive problems in children with intellectual disabilities are of mental and social nature. When these children participate in a group counseling session, they learn to replicate the constructive characteristics of other children and gain a better understanding of their own problem by observing the behavior of others. Group-based sessions give an opportunity to a child to find new and better ways of interacting with others and resolving problems. Additionally, it creates a basis for the child to learn continually. The benefits of such training program are skill enhancement, reduction of stress, improved attitude, enhanced teacher-pupil interaction, and a better functioning within the family (39, 41).

In general, significant changes in children in the above-mentioned areas can be associated with the effect of education on improving child interactions, attitude changes toward cognition and problems of

other children, efficient management of handling problems, and controlling impulsive behaviors. Additionally, the use of appropriate and timely cautions, rewards, and punishments can influence their behavior. A significant reduction of the problems can also be attributed to an increase in the ability to motivate a child to perform school assignments by offering suitable rewards. However, compared to normal children, the tasks of mental focus, recognition, and orientation are more challenging for children with intellectual disabilities. It requires more patience, skills, and adequate abilities in mental management and cognitive flexibility. The more education one receives in cognitive flexibility, skills and executive functions, the more able s/he becomes in managing mental issues and the ability to focus, language comprehension, learning, improved memory, and abstract conceptualization. In this regard, both intellectually disabled child and his/her family should be provided with education on flexibility skills, so that they can understand and resolve issues in different situations. Implementation of such training programs would contribute to the prevention, control, and treatment of cognitive problems.

Conclusion

As a general conclusion, it can be stated that cognitive flexibility training done in 15 sessions of 30-45 minutes had a positive effect on reducing the cognitive problems of 13-to-18-year-old female adolescents with intellectual disabilities. Given that such children have difficulties in learning, memory, language, etc., the inclusion of a cognitive flexibility training program is recommended alongside other rehabilitation plans for both behavior and speech as well as social and cognitive rehabilitation. It is also essential to raise awareness of such needs among specialists, parents, teachers, and other health care providers to include cognitive flexibility training in their rehabilitation, treatment, and educational programs. Their contribution - within their limits - toward social awareness and the adaptability of intellectually disabled children is recommended. They should at least think about incorporating cognitive flexibility training into their overall programs.

Study Limitations

The present study had some limitations which should be mentioned for a better interpretation of our results as well as considerations in future research studies. First, the participants were not fully involved in the present study and training program. The other limitations include small sample size, the wide age range of the participants, lack of consideration to the intelligence level of the participants, and enrollment of only the adolescents with intellectual impairments. Moreover, the active participation of the parents can help reach better results.

Recommendations

- Holding a workshop for parents and teachers on the importance of cognitive flexibility in daily life and on the ability to learn
- Creating favorable conditions to increase the participation of parents, particularly the mothers
- Providing a rich learning environment by school managers and teachers and the use of dedicated games, allowing the adolescents to reinforce and improve their cognitive flexibility and reduce cognitive problems
- Considering cognitive flexibility as the main focus of the educational curriculum for adolescents with

special needs, qualified professionals should implement both the treatment and the education program.

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