Clinical Cancer Investigation Journal-ISSN: 2278-0513

Computer-assisted cognitive rehabilitation/improvement of selective-divided attention in individuals with down syndrome

Abstract

The present study aims at determining the effectiveness of cognitive rehabilitation using the computer in improving selective and divided attention in individuals with Down Syndrome. The study was conducted with a semi-experimental design of the single-testee type with several baselines. Nine patients with down syndrome were selected based on a convenience method. Then, the testees were placed on three baselines, and after the three-, five- and seven-week baselines were terminated, the testees were allowed to randomly enter treatment. The intervention took 20 sessions to complete. To investigate and assess the cognitive variables, the testees were evaluated based on Voxler's Intelligence test (direct-inverse digit span) as well as Tower of London, continuous functioning, Stroop effect, and Corsi's cubes tests. The visual statistical analyses are reflective of the idea that the testees' scores have not changed in the impact size and improvement percentage. The results signified that cognitive rehabilitation is effective in improving the cognitive deficits (selective and divided attention types) amongst children and adolescents with Down Syndrome.

Keywords: *Down Syndrome, Cognitive rehabilitation, Cognitive deficits of the working memory, Constant attention, Divided attention*

Zahra Edalatjoo*
Master of Clinical Psychology, Borujerd University of Research Sciences, Iran
zahra z.edalatjoo@gmail.com

Introduction:

The reality-based estimations indicate that 750 million children might experience mental disabilities in the span between birth and five years of age (Olness, 2003; Das-Munshi, Chang, Dregan, Hatch, S., Morgan., Thornicroft. Hotopf. (2021)). This figure is reflective of the growth in several identifiable biological and environmental factors that might give rise to mental disabilities. There is also evidence signaling that certain conditions are making a child be envisioned as at risk, in addition to several genetic and infectious proofs that have been known to contribute to mental disability. The conditions that can cause mental disability are malnutrition, fetus's addiction to alcohol, cerebral trauma, lead poisoning, low birth weight, cancer, and so forth. Environmental causes might be poverty, misuse of the details, and child ignorance (Guralnick, 2005; Beard, Officer, & Cassels, (2016).). These environmental causes often work in association with biological factors (Msall et al., 1998).

Moreover, when the potential or risk factors are investigated, an added effect can be attained by expressing the biggest threat to the children's mental improvement (Burchinal et al., 2000 Sameroff et al., 1987). Several children who might probably experience mental inability worldwide are only supported using a diverse and complicated array of recovery patterns.

Down Syndrome has been recognized as the most common chromosome disorder. Down syndrome has always been followed by a high likelihood of mental retardation, but this does not mean that the individual cannot learn. Studies show that DS individuals very well have an eighty-percent competency for learning the initial concepts (Koegel, 2006; Hepburn, 2003; .(Hekal, Darwish, Attia, Osman & Ehsan ;2017)). Considering these children's cognitive defections, they need proper interventions.

So far, no medically specific treatment method has been found for the definite treatment of down syndrome. Of course, paying complete attention to DS children's hygiene, appropriate nutrition, and required medical care and, more importantly, offering rehabilitation and training-specific programs are of greater importance regarding the treatment and/or improvement of the physical status hence the advancement of these children's mental actions (Afruz, 2004).

Work therapy and rehabilitation are the only efficient, and well-documented treatments therapists can utilize for the treatment of individuals with down syndrome. Empirical research has constantly indicated that such treatments can lead to the reduction in a limited number of disruptive behaviors as well as improvement in the physical status of the children, youths, and adolescents with this disease (Iran's national healthcare institute, 2000. Pelosi, Ferreira, & Nascimento 2020).

). However, it has to be necessarily asserted that none of the treatment and pharmaceutical interventions has so far directly targeted the cognitive problems accompanied by Down syndrome. Cognitive rehabilitation has been proved a promising treatment for cerebral damage, schizophrenia, hyperactivity, speaking disorders, MS, Alzheimer's, and dementia-induced cerebral atrophy. This way of treatment tries to repair memory, attention, language learning, decision-making, planning, problem-solving, and the brain's executive functions. Nowadays, all the healthcare experts and

neuropsychologists have come to this idea based on the scientific studies' results that computer-aided brain exercises within various formats can cause improvement in abilities and enhance brain functioning through simple and complex processes. Due to the same reason, neurological tools and computer-assisted cognitive rehabilitative exercises can be used to remove the cognitive flaws, including in memory, attention, learning, language, and decision-making within various treatment formats. Amongst the primary benefits of such a way of treatment is the ability of its implementation in limited space (computer) and its very high fascination for children below 13 years of age in contrast to the other treatment methods. Considering the abovementioned materials, the present study aims at determining the effectiveness of computer-based cognitive rehabilitation in improving selective and divided attention amongst individuals with Down syndrome.

Study Method:

The present study is experimental research of a single-testee design type with several baselines. In this research, there are three types of three-, five- and seven-week baselines, with nine subjects falling in three-by-three format on these three baselines upon the termination of which they are allowed to enter the treatment. The effectiveness rates of the treatment are compared for every individual concerning his or her and other individuals' baselines .All of the girls and boys with Down syndrome enrolled in schools for the mentally retarded persons in Delfan County and Shahid (Martyr) Nazarzadeh school for mentally retarded individuals in Khorram Abad County for the academic years 2013-2014 (n=16) form the study's population. Out of the DS children enrolled in Tolu'e Schools for Mentally Retarded Persons in Delfan County and Shahid Nazarzade School for Mentally Retarded Persons in Khorram Abad County, nine were selected based on a convenience method. The study sample's participants were in an age range from 9 to 17.

To identify the Down syndrome and psychotic and organic disorders and, generally, the qualification for the study inclusion criteria and disqualification for the study exclusion criteria, the subjects' medical files were studied. Furthermore, to reject the cases with auditory and organic conditions, the testees' medical histories were inspected in cooperation with the schools' counselors and mothers. Voxler's test of intelligence was conducted to recognize the intelligence range by a clinical psychologist.

Study Instrument:

1. **Cogniplus Software:**

   The software was constructed for teaching cognitive functions by Schuhfried Company, Austria, in 2006, and it uses a multimedia approach. The subjects are asked in an application of the software to apply what they have learned during the day. The software features parts for identifying the working memory's performance, divided attention, constant attention, information processing, problem-solving and selective attention.

2. **Direct Digit Span Test:**

   The tester randomly reads a set of single-digit numbers, and the testee is asked to repeat them in the same order. The series of numbers seminally consisted of two digits, and then, after every round of reading the numbers, one number is added so that a series of seven-digit numbers are reached. The test is stopped when the child repeats a chain of numbers with the wrong order two consecutive times. The children are not provided with any feedback in the course of the test. The performance is scored as the total number of series recalled in the correct order.

3. **Inverse Digit Span Test:**

   This test is executed like the direct digit span test, except that the child should recall the numbers in inverse order. The test is scored in the form of the number of correct recalling. The test has been successfully run for 6- to 7-year-old children and even 4-year-old children .A high rate of correlation has been documented for this test's central executive scales, with its test-retest reliability having been found equal to 0.62.

4. **Computer-Based Stroop Effect Test:**

   The Stroop effect test is a classical laboratory model for the evaluation of selective attention. The test evaluates selective attention or the attention capacity, especially with the presentation of a stimulus, and it allows an individual to focus on a particular input and simultaneously suppress irrelevant distracting information. The test is comprised of two parts: the first part includes the representation of four colors (yellow, red, blue, and green) in circular forms on a computer's display screen. Fifty colorful circles are presented randomly in each of the four colors yellow, red, blue, and green. Every circle appears for an uncertain time. The testee has to press the tab with the same color as the circle shown on the display screen.

The goal is to find out if the subject can correctly recognize the colors and if s/he is capable of reading or not.

The second part includes the presentation of words in similar and dissimilar colors. Forty-eight words of the same color and 48 words of different color are displayed each for two seconds on a computer's display screen in a random order of yellow, red, blue, and green colors. The interval between two stimuli is 800 milliseconds. The testee has to pay attention just to the color of a word and disregard the meaning thereof. For example, a word previously shown in blue is displayed for the second time in green, and the testee should press the green tab..

5. Constant Performance Test:

It is recognized as the most common laboratory instrument for assessing care, and it is widely applied for the evaluation of hyperactivity along with attention deficit. It has been prepared for treatment and research purposes, and, in all its forms, the testee should direct his or her attention for a while towards a relatively simple auditory or visual set of stimuli and provide his or her answer by pressing a key with the emergence of the target stimulus. In most recent studies, visual stimuli are displayed on a screen for a short time, and the testee should respond to the target stimulus by pressing a key on the keyboard .In this test, there are 150 Persian numbers or images as the stimuli, and out of the aforesaid number, 30 (20%) are the target stimuli, and 120 (80%) are the non-target stimuli. Every stimulus is displayed for 200 milliseconds, and the interval between every two stimuli is a second. Considering the exercise stage that serves to provide the testee with a perception of the test, the test takes 200 seconds to complete.

In this test, two kinds of errors are counted by a computer application. In addition, the number of correct answers and the reaction time are taken into consideration. As shown in the studies by Dr. Hadianfard et al., the Persian version of the constant performance test (CPT) features good reliability and validity. In their study, the test-retest reliability of various test parts was in a range between 52% and 93%. The test validity was calculated using a criteria validity test by comparing a normal group (30 primary school boys) and an AHDH group (25 primary school boys). The mean values of the two groups were compared for various parts of the test, and a significant difference was observed between the two group's performances ($p<0.01$). The study results were found consistent with the findings of the prior research in other countries.

6. Tower of London Test:

The test is one of the important instruments for measuring the actions while organizing and programming (Krikorian et al., 1994, Lezak et al., 2004; Baron, 2004). Since the test's implementation in a computer-based manner could have a lot of advantages, including precision in implementation and precise measurement of the results such as the number of correct and wrong answers as well as the accurate timing of the stages, the initial version of the test was prepared in the form of a computer application based on Delphi programming language in Sina Cognitive-Behavioral Sciences Research Institute. The test's goal is to assess the maximum extent to which a testee can make use of his or her abilities and the maximum speed with which s/he can exhibit the best of his or her performance. Before running the test, the testee's skillfulness in moving the computer's mouse should be ensured. The testees are asked to move colorful (green, blue, and red) beads and put them in their right place by the least required movement to form a correct shape. The individuals who succeed in this test are considered to have high problem-solving, programming, evaluation, and decision-making power. The test takes between 11 to 16 minutes to finish. A good correlation rate ($r=0.41$) has been reported between the results of this test and the results of Proteus's maze (Culbertson and Zillmer, 1998; Krikorian et al., 1994).

7. Corsi's Cubes Test:

It is a computer test in which nine dark rectangles are shown on the screen; each rectangle is brightened when the arrow points at it; after a short while, the testee has to brighten the rectangles in a previously shown order. At first, two rectangles are brightened, and then another rectangle is added in every round until there are six rectangles to be brightened in a previously shown order. The test is stopped in case a testee happens to brighten the rectangles in the wrong order for two consecutive rounds. The performance is the measure of the entire series correctly learned by the testee. The test-retest reliability of Corsi's cube test is equal to 0.53, and the score obtained in Corsie's

cube test is usually expressive of working memory's spatial-visual span.

Study Methodology:

At first, a diagnostic interview was made by the psychiatrist with the students to recognize the existence of Down syndrome and the absence of psychotic and organic disorders. Voxler's test of children was carried out to identify their intelligence range by a clinical psychologist. The boy and girl students diagnosed with Down syndrome and lacking the study exclusion criteria were placed on various baselines. The subjects were put three-by-three on three types of three-, five- and seven-week baselines for the measurement of the dependent variables. The testees were randomly selected for all three kinds of the baseline. On every baseline, the working memory was assessed as a variable based on the calculation of the scores obtained in subscales like direct digit span, inverse digit span, and Corsi's span.

Problem-solving was assessed based on the scores obtained in the Tower of London Test. The selective attention was calculated based on the number of errors and number of omitted similar and dissimilar stimuli in the Stroop effect test. Additionally, the constant attention and information processing of the baselines were recorded based on the constant performance rates computed for the testees. Then, the testees from various baselines were allowed to enter the treatment plan. The first, the second, and the third testees entered the treatment process after three points of the dependent variable's measurement; the fourth, the fifth, and the sixth testees after five points of the dependent variable's measurement and the seventh, eighth and ninth testees after seven points of the dependent variable's measurement. The intervention was conducted within twenty 45-minute sessions. One month after the treatment, the dependent variable's score was again calculated.

Treatment Procedures:

The first group of testees received the following treatments in the first session. After ten sessions, the testees were reevaluated. From session 11 to session 15, the testees were given motor-visual and memory assignments in addition to their fourfold assignment (constant, concentrated, selective, and divided attention). After fifteen sessions, the testees were subjected to the Stroop effect test, constant performance test, Corsi's test of cubes, direct and inverse digit spans' test, and tower of London test. During session 15 to session 20, the testees were trained for all of the abovementioned tests. After session 20 was over, the testees were again evaluated. And after one week after the termination of session 20, the Stroop effect test, constant performance test, Corsi's cube test, direct and inverse digit test, and tower of London test were carried out.

The second group was still being evaluated when the first group of testees entered the treatment. In session three of the treatment, the first and the second groups entered the treatment after five sessions of evaluation. The treatment and assignment processes were like those of the first group, and the evaluations were also conducted after five, ten, fifteen, and twenty sessions. After one week, a follow-up test was undertaken based on the Stroop effect test, constant performance test, Corsi's cube test, direct and inverse digit test, and tower of London test.

The third group was still being evaluated when the first and the second groups entered the treatment. The third group entered the treatment after seven sessions of evaluation when the first group had completed seven treatment sessions and the second group had had five sessions of treatment. The treatment and assignment processes were like those of the first and second groups, and evaluations were done after five, ten, fifteen, and twenty sessions. Stroop effect test, constant performance test, Corsi's test of cubes, direct and inverse digit test, and tower of London test were carried out after a week following the termination of the treatment within the format of a follow-up test. It is worth mentioning that the testees were given the needed explanations about the treatments' implementation method at the beginning of every exercise program.

Computer-Assisted Cognitive Reparatory or Rehabilitative Treatment Package:

Cognitive healing was carried out using Cogniplus software. In this application, the subjects are asked to apply what they have learned in their daily life in the presented exercises. Rehabilitative training is conducted in twenty 45-minute sessions thrice a week. Various images are displayed one after the other, and the testees should compare every image with the previous one. If it is found to be similar to the previous one, they have to press the confirm key; otherwise, they should press the Ctrl key. In level three of the test, three various images are shown consecutively, and the testee should compare the current image with the two previous images.

To investigate and analyze the behavioral data, the present study has used the visual analysis method, Cohen's d size, improvement percentage (when the goal is increasing a behavioral type), and mean reduction percentage (when the goal is reducing a behavioral type).

Result:

The results indicated that cognitive rehabilitation using a computer causes improvement in the DS children's selective attention. The visual inspection of the diagram can investigate the change in the intensity of the signs and symptoms based on three procedures (level, slope, or changeability). Diagrams in figure (1) and table (1) show that there are three baselines with a lot of changeability recorded in one group. The scores' variability is often observed in the intervention stage, and the level created in the follow-up stage remains relatively fixed. As it is observed, when the first group entered the treatment process, the second and the third groups were still on their baselines, and when the first group started changing, the other two groups were not found with any changes in their scores. Change in the level has been started for all three groups after the entry into the treatment, and, before that, the changes were mostly of the types specific to DS children. Out of the nine study cases, all were found to have undergone reductions in their scores of cognitive interference in processing two consecutive stimuli's information and similar/dissimilar stimuli omissions in the course of treatment. The reduction in cognitive interference score was observable since the initial sessions. The cognitive interference percentage and the impact size were found to be very high for all of the cases.

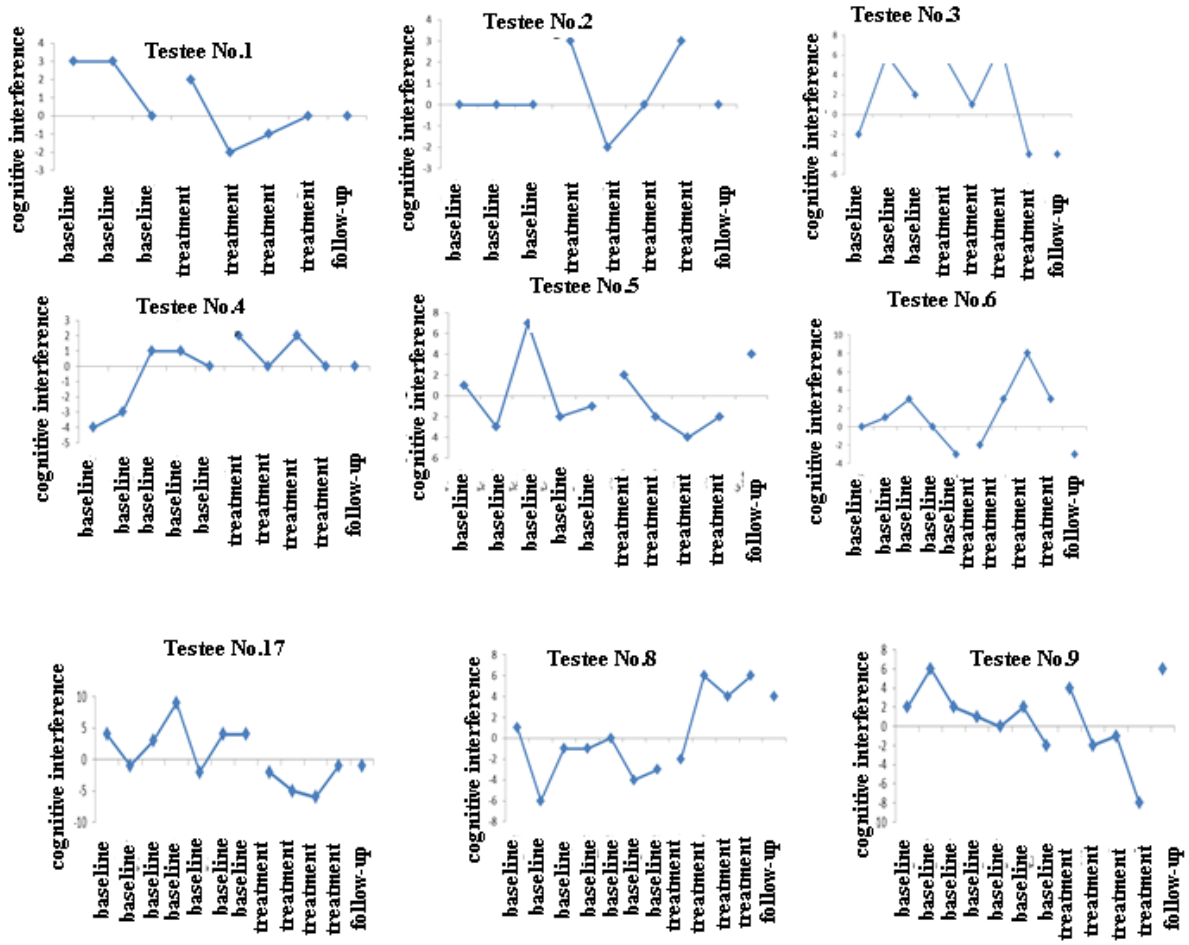

Table 1: cognitive interference scores

Stroop effect test score	Testee No.1	Testee No.2	Testee No.3
MPI	900	100	20
MPR	113	-	25

D	-1.23	0.6	0.13
	Testee No.4	Testee No.5	Testee No.6
MPI	200	127	93
MPR	200	475	14
D	1.02	-0.6	0.9
	Testee No.7	Testee No.8	Testee No.9
MPI	186	157	190
MPR	217	275	211
D	-1.51	1.46	-0.94

In all of the above nine cases, a direct reduction slope is observed in the interference score for the initial sessions, but the increase in the number of treatment sessions is found to have led to intensive reductions in the interference score and reaction time as marked by steep slopes in the diagrams. These steep reductive slopes are reflective of the changes in the selective attention of individuals with Down syndrome; however, it is observed that the increase in the sessions does not end in any further decrease in the interference score and reaction time from a given point at which the lines reach balance and remain non-fluctuating. From amongst the nine above cases, all, except testee no.6, for which an improvement rate of 14% has been calculated, have undergone improvements in interference score and reaction time above 100%. Thus, the second hypothesis is confirmed.

As it is seen, the experimental application has influenced the selective attention in participant no.1. The impact size indicates that the interference score is about 1.5, and it has been improved in contrast to the baseline. The improvement in the interference score was 113% for participant no.1 as compared to the baseline.

The results indicated that cognitive rehabilitation using computers causes improvement in the divided attention of children with Down syndrome. The diagrams' visual inspection enables the tracking of changes in the intensity of the signs based on the three procedures (level, slope, or changeability trend). Diagrams in figure (2) and table (2) show that there are three baselines recorded for the testees in the first group, with them featuring low changeability. The variations in the scores are often observed in the intervention sage, with the level created in this stage remaining relatively fixed, as evidenced in the follow-up stage. As it is seen, the second and the third groups were still in the baseline stage when the first group entered the treatment, and there is observed no changeability in their scores even after changes started appearing in the first group. Change in the levels starts for all of the three groups after the treatment's commencement, before which the changeability is limited to variations that are specific to children with Down syndrome. Out of the nine study cases, all have exhibited increases in their divided attention and inverse digit test scores in the course of treatment. The increase in the divided attention started emerging from the early sessions. The percentages of increase in the inverse digit span test and the impact sizes have been very high for all of the cases.

In all of the nine cases studied herein, a direct ascending slope is not observed for the inverse digit span test during the early sessions, but the slope is found ascending for the score of the inverse digit span test with the increase in the number of the treatment sessions. This is pertinent to the changes in the DS individuals' divided attention; however, it is seen following the increase in the number of sessions that the slope does not ascend anymore and reaches an equilibrium, and does not undergo any fluctuation. Amongst the nine studied cases, participant no.4 has succeeded in providing correct answers during sessions fifteen to three of the inverse digit span tests, so the first hypothesis is affirmed.

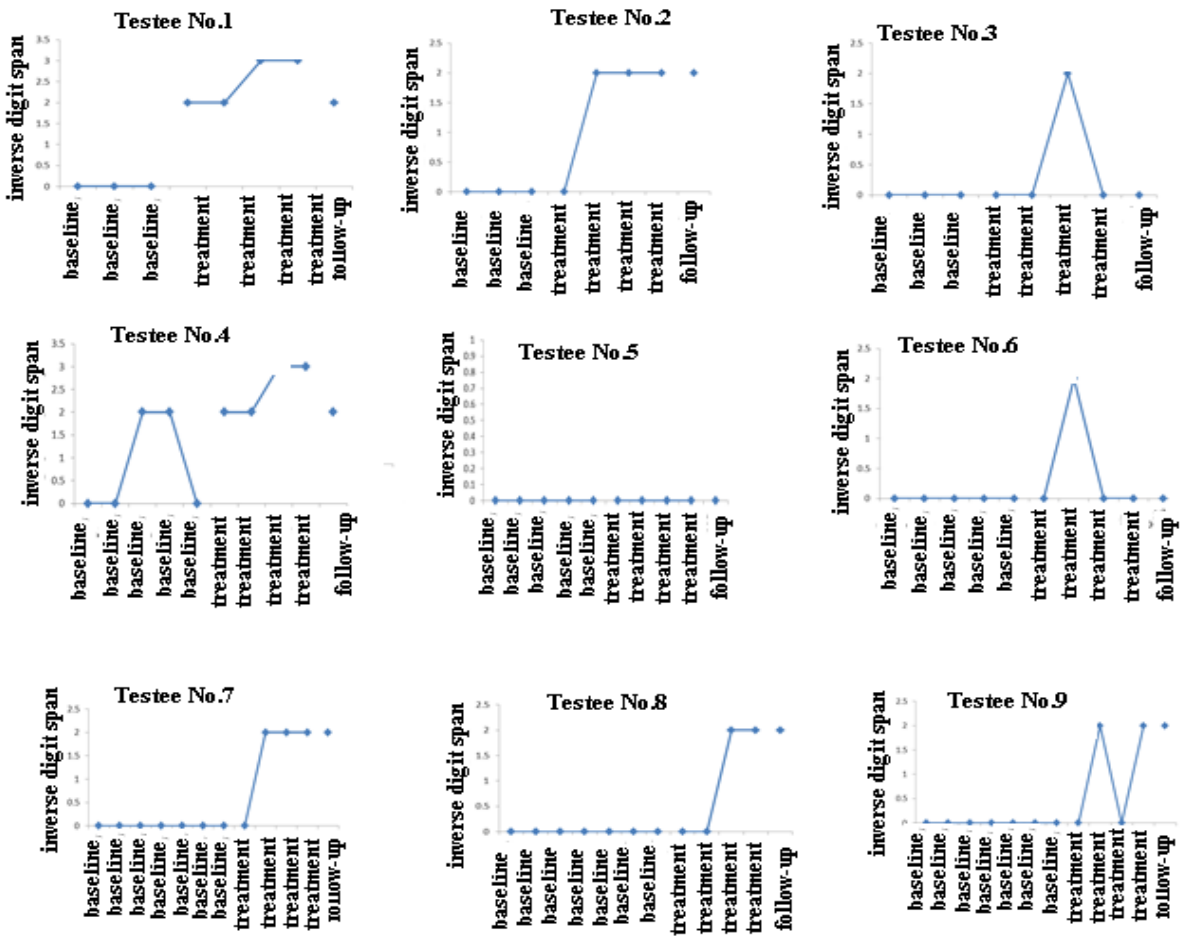

Figure (2): diagrams of change in the intensity of interactions based on the three procedures

Table 3: digit span test

	Testee no.1		**Testee no.2**		**Testee no.3**	
	Direct	Inverse	Direct	Inverse	Direct	Inverse
MPI	41	100	27	100	100	100
MPR	69	-	38	-	-	-
D	1.78	1.8	1.52	1.52	1.11	0.71
	Testee no.4		Testee no.5		Testee no.6	
	Direct	Inverse	Direct	Inverse	Direct	Inverse
MPI	41	84	100	-	100	100
MPR	70	525	-	-	-	-
D	1.3	1.82	1.2	-	0.8	0.8

	Testee no.7		Testee no.8		Testee no.9	
	Direct	Inverse	Direct	Direct	Inverse	Direct
MPI	71	100	100	100	71	100
MPR	250	-	-	-	250	-
D	1.09	1.68	1.68	1.3	0.8	1.3

As it is observed, the experimental application has influenced the divided attention in testee no.1, with the impact size being reflective of an improvement in the divided attention performance by about 2 in contrast to the baseline. In testee no.2, as well, the experimental application has influenced the divided attention performance, and the impact size exhibits that the divided attention performance has undergone improvement by about 1.5 in contrast to the baseline. In testee no.3, the experimental application has influenced the divided attention performance, and the impact size is reflective of the improvement in the divided attention performance by about 0.73 in comparison to the baseline. The experimental application has also influenced the divided attention performance in participant no.4, with the impact size being indicative of the improvement in the divided attention performance by about 1.5 in comparison to the baseline. The percentage of improvement in the divided attention is 23 for participant no.4 in contrast to the baseline.

The experimental application has been found not to influence the divided attention performance in testee no.5, so no impact size could be reported. In testee no.6, the experimental application has influenced the divided attention performance, with the impact size being reflective of an improvement by 0.8 in the divided attention performance of testee no.6 in contrast to the baseline. The experimental application has influenced testee no.7's divided attention performance, with the impact size being expressive of an improvement by about 2 in the divided attention performance in contrast to the baseline. The experimental application has influenced testee no.8's divided attention performance, with the impact size being indicative of an improvement by about 1.3 in the divided attention performance in contrast to the baseline. The experimental application has influenced testee no.9's divided attention performance, with the impact size being reflective of an improvement by about 1.3 in the divided attention performance in contrast to the baseline.

discussion **&** **Conclusion:**

So far, no specific medical treatment has been found for the absolute treatment of Down syndrome. Of course, the thing of the greatest importance about the treatment or improvement of the physical status hence the advancement of the DS children's mental actions is perfect paying of attention to their hygiene, proper nutrition, and the required medical care and, more importantly, allowing the enter specific rehabilitation and educational programs (Afruz, 2009).

However, it has to be necessarily asserted that none of the therapeutic and pharmaceutical interventions directly targets the cognitive problems accompanied by Down syndrome.

Cognitive rehabilitation has been proved a promising treatment for cerebral damage, schizophrenia, hyperactivity, speaking disorders (dyslexia), MS, Alzheimer's, and dementia-induced cerebral atrophy. This way of treatment tries to repair memory, attention, language learning, decision-making, planning, problem-solving, and the brain's executive functions. Using neurological tools and computer-assisted cognitive rehabilitative exercises, therapists try removing the cognitive flaws, including in memory, attention, learning, language, and decision-making within various treatment formats. Studies are indicating that the cognitive interventions enable DS individuals to create cognitive functions' improvements (memorization, attention, short-term memory, and learning) that last for their whole life.

Results indicated that the computer-aided cognitive repair (rehabilitation) causes improvement in the DS children's selective attention. The second hypothesis's analysis indicated that the computer-assisted cognitive rehabilitation of DS children brings about improvements in their selective attention. A glance at the testees' impact sizes makes it clear that the interference scores of these children have changed after the intervention as a result of their being trained by the experimental application. Computer-aided cognitive repair (rehabilitation) causes improvement in the divided attention of

DS children. The study analyses showed that the computer-assisted cognitive rehabilitation of DS children causes improvement in their divided attention. A glance at the impact sizes of the testees' scores on the inverse digit span test makes it clear that the children have undergone changes and improvements in this test. The results are consistent with what has been found by Storm and Williams (1998), who showed that the visual training of individuals with brain damage could bring about an enhancement in their divided attention following 14 sessions of treatment.

Ethical considerations: Ethical principles are fully observed in this article. Including the principle of confidentiality, confidentiality of personal information, consent and informed participation in the research.

Fund: This contest has no financial sponsor.

Conflict of interest: The authors declare that there is no conflict of interest in the present study.

Thanks:We thank all the families of Dunn syndrome who helped us in this research.

References:

- Afruz, Gholam Ali, (2009), "Exceptional Children's Psychology and Education," 20th ed., Tehran, pp.23-30
- Burchinal, M. R.; Roberts, J.; Hooper, S. and Ziesel, S. A., (2000), "Cumulative risk and early cognitive development: a comparison of statistical risk models," Developmental Psychology, 36:793–807
- Culbertson, W. C. & Zillmer, E. A., (1998), "The construct validity of the Tower of London DX as a measure of the executive functioning of ADHD children," Assessment, *5*:215-226
- Fujiura, G. T. & Yamaki, K., (2000), "Trends in the demography of childhood poverty and disability," Exceptional Children, 66:187–199
- Guralnick, M. J., (2005a), "An overview of the developmental systems approach to early intervention," In M. J. Guralnick (ed.), The Developmental Systems Approach to Early Intervention, Baltimore: Brookes, pp. 3–28
- Hepburn, S. L., (2003), "Clinical implications of temperamental characteristics of young children with developmental disabilities," Infants and Young Children, 16:59–76
- Koegel, R. L. & Koegel, L. K., (2006), "Pivotal Response Treatments for Autism," Baltimore: Brookes
- Krikorian, R., Bartok, & Gay, N., (1994), "Tower of London procedure: A standard method and developmental data," Journal of Clinical and Experimental Neuropsychology, 16:840-850
- Lezak, M. D.; Howieson, D. B.; Loring, D. W.; Hannay, H. J. and Fischer, J. S., (2004), "Neuropsychological assessment," 4th ed., Oxford University Press, New York
- Msall, M. E.; Bier, J.; Lagasse, L.; Tremont, M. And Lester, B., (1998), "The vulnerable preschool child: the impact of biomedical and social risks on neuro-developmental function", Seminars in Pediatric Neurology, 5:52–61
- Olness, K., (2003), "Effects on brain development leading to cognitive impairment: a worldwide epidemic", Journal of Developmental & Behavioral Pediatrics, 24:120–130
- Sameroff, A. J. & Chandler, M. J., (1975), "Reproductive risk and the continuum of caretaking causality", In F. D. Horowitz, E. M. Hetherington, S. Scarr-Salapatek, G. Siegel (eds.), Review of Child Development Research, Chicago: University of Chicago Press, 4:187–244.
- Das-Munshi, J., Chang, C., Dregan, A., Hatch, S., Morgan, C., Thornicroft, G., . . . Hotopf, M. (2021). How do ethnicity and deprivation impact on life expectancy at birth in people with serious mental illness? Observational study in the UK. *Psychological Medicine, 51*(15), 2581-2589. doi:10.1017/S0033291720001087
- Pelosi, M. B., Ferreira, K. G., & Nascimento, J. S. (2020). Occupational therapy activities developed with children and pre-teens with Down syndrome. *Cadernos Brasileiros de Terapia Ocupacional*, *28*, 511-524.
- Hekal, O. A. E. A., Darwish, M. M., Attia, A. A. M., Osman, Z. A. E., & Ehsan, I. A. (2017). Effect of selected play activities on adaptive skills, among children with Down syndrome. International Journal of Science and Research, 5(11), 77-86.
- Beard, J. R., Officer, A. M., & Cassels, A. K. (2016). The world report on ageing and health. *The Gerontologist*, *56*(Suppl_2), S163-S166.