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RESEARCH ARTICLE

Effect of an executive function cognitive training program on the planning component in adults with mild intellectual disability

Efecto de un programa de entrenamiento cognitivo de la función ejecutiva sobre el componente de planeación en adultos con discapacidad intelectual

Efeito de um programa de treino de funções executivas cognitivas na componente de planeamento em adultos com deficiência intelectual ligeira

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Abstract

Introduction: Disability today is represented in approximately 1 billion people worldwide, whose condition generates limitations that encompass functional, adaptive and cognitive **Objective:** to evaluate the effect of a computerized cognitive training program on the executive function of planning in people with mild intellectual disability. **Methodology:** A quasi-experimental design was used with 10 participants, who received 20 training sessions for 2 months. Planning skills were evaluated before and after the program. **Results:** Significant improvements in planning skills were evidenced after the training. Participants were able to complete the maze and king figure tasks in less time, indicating greater efficiency in problem solving. These findings support the effectiveness of computerized cognitive training in improving cognitive performance in people with mild intellectual disability. **Conclusions:** These results are relevant in the field of neuropsychology, as they demonstrate that computerized programs can have a positive impact on the development of executive functions in this population. In addition, they highlight the importance of using interactive and technological approaches in psycho-pedagogical and neuropsychological interventions.

Keywords: Computerized; Disability; Cognitive training; Executive function; Planning.

Resumen

Introducción: La discapacidad hoy en día está representada en aproximadamente 1000 millones de personas en todo el mundo, cuya condición genera limitaciones que abarca lo funcional, lo adaptativa y lo cognitivo **Objetivo:** evaluar el efecto de un programa de entrenamiento cognitivo computarizado en la función ejecutiva de la planeación en personas con discapacidad intelectual leve. **Metodología:** Se utilizó un diseño cuasiexperimental con 10 participantes, quienes recibieron 20 sesiones de entrenamiento durante 2 meses. Se evaluaron las habilidades de planeación antes y después del programa. **Resultados:** Se evidenciaron mejoras significativas en la capacidad de planificación después del entrenamiento. Los participantes lograron realizar las tareas de laberintos y figura de rey en menos tiempo, indicando una mayor eficiencia en la resolución de problemas. Estos hallazgos respaldan la efectividad del entrenamiento cognitivo computarizado en la mejora del desempeño cognitivo en personas con discapacidad intelectual leve. **Conclusiones:** Estos resultados son relevantes en el ámbito de la neuropsicología, ya que demuestran que los programas computarizados pueden tener un impacto positivo en el desarrollo de las funciones ejecutivas en esta población. Además, resaltan la importancia de utilizar enfoques interactivos y tecnológicos en las intervenciones psicopedagógicas y neuropsicológicas.

Palabras clave: Computarizado; Discapacidad; Entrenamiento cognitivo; Función ejecutiva; Planeación.

Resumo

Introdução: Atualmente, a deficiência é representada por aproximadamente 1 bilhão de pessoas em todo o mundo, cuja condição gera limitações funcionais, adaptativas e cognitivas **Objetivo:** Avaliar o efeito de um programa de treinamento cognitivo computadorizado sobre a função executiva de planejamento em pessoas com deficiência intelectual leve. **Metodologia:** foi usado um projeto quase experimental com 10 participantes, que receberam 20 sessões de treinamento durante 2 meses. As habilidades de planejamento foram avaliadas antes e depois do programa. **Resultados:** Foram evidenciadas melhorias significativas nas habilidades de planejamento após o treinamento. Os participantes conseguiram concluir as tarefas do labirinto e da figura do rei em menos tempo, indicando maior eficiência na solução de problemas. Esses resultados corroboram a eficácia do treinamento cognitivo computadorizado para melhorar o desempenho cognitivo em pessoas com deficiência intelectual leve. **Conclusões:** Esses resultados são relevantes no campo da neuropsicologia, pois demonstram que os programas baseados em computador podem ter um impacto positivo no desenvolvimento das funções executivas nessa população. Além disso, destacam a importância do uso de abordagens interativas e tecnológicas em intervenções psicopedagógicas e neuropsicológicas.

Palavras-chave: *Baseado em computador; Deficiência; Treinamento cognitivo; Função executiva; Planejamento.*

INTRODUCTION

Historically, the conceptualization of intellectual disability and its clinical manifestation have undergone significant changes since the 18th century. At that time, anyone exhibiting behavior outside the commonly accepted norm was considered "abnormal" (Schalock et al., 2021). However, this perception has evolved over time, driven by ongoing research in the field and the transformation of sociocultural thinking.

It was not until 1992 that a concept was consolidated that attempted to explain more precisely the clinical manifestation of people with intellectual disabilities (Schalock et al., 2021). This concept has been approached from various perspectives in psychology, including psychometric, developmental, psychodynamic, cognitive and functional behavior analysis approaches. Despite the differences in these approaches, they all agree that intellectual disability implies a global alteration of cognition and adaptive skills, which prevents the person from developing with autonomy and independence in a social and cultural context (Alonso, 2003).

In 2010, Alonso proposed a redefinition of intellectual disability as "a disability characterized by significant limitations in intellectual functioning and adaptive behavior, manifested in practical, social and conceptual skills, beginning before the age of 18". Based on this definition, five essential premises were established for a multidimensional diagnosis that encompasses various aspects of the individual and his or her environment, in order to optimize supports and thus improve individual functioning.

According to this proposal, the identification and characterization of a person with intellectual disabilities should include the evaluation of the following aspects: a) intellectual abilities, b) adaptive behavior, c) participation, interactions and social roles, d) health (physical, mental and etiology), and e) context (environment and culture). Thus, the objective of an intervention is to improve the supports (therapeutic, family, school and social) that facilitate better functioning (Alonso, 2003; Alonso, 2010).

From a neuropsychological perspective, Rosselli et al. (2010) suggest that cognitive processes such as attention, memory, gnosias, praxias and language are affected in people with intellectual disabilities. However, it is the executive functions that show the greatest evidence, since they underlie the activation of other functions such as memory, attention, cognitive flexibility and spatial and temporal perception. These functions make it possible to generate actions of super- vision, regulation, execution and readjustment of behaviors to achieve complex goals, especially those that require a novel and creative approach.

In everyday life, most of the situations we face are unique and evolve in complexity as we develop as adults with new interests and responsibilities. Executive mechanisms are essential in a wide variety of situations and stages of life, being crucial for optimal and socially adapted functioning (Alonso, 2005).

Cipolotti and Warrington (1995) define the planning component as "the ability to organize and sequence the steps necessary to carry out an action for a given purpose". This implies the skills needed to carry out an intention or achieve an objective, taking into account the following

The changes in present and future circumstances, as well as the environment in which the person develops, are taken into account. Lopera (2008) emphasizes the importance of this component in the execution of action, since it allows the person to project and undertake action plans to achieve his or her goals.

Failure to strengthen this component in people with intellectual disabilities can generate difficulties in the performance of daily activities, limiting productivity and efficiency, which can hinder the development of the person in the family, academic and work environments, affecting their quality of life and that of their families.

Some studies suggest that cognitive training programs can enhance cognitive aspects. Cordoba (2019), in a study with 8 children with mild intellectual disabilities, reported improvements in aspects related to response speed after training, especially in copying the king figure and PASAT. The researchers attribute these achievements to collaborative work and accompaniment, which could boost goal attainment.

De La Torre-Salazar et al. (2017) conducted a quasi-experimental study to verify whether a computerized executive function training program could improve executive functions in a group of 20 children with intellectual disabilities. The findings revealed the effectiveness of the program for both the control group and the experimental group.

In another study conducted by Ríos et al. (2014) at the Liceo de la Universidad Católica de Colombia, they worked with 16 children in the transition grade. The main objective was to analyze the results of an online cognitive training aimed at stimulating the planning function. The results showed improvements in aspects related to planning, reflected in increases in the number of correct designs and in the number of correct designs with the minimum number of movements. This study highlights the usefulness of interactive devices to promote learning, maintaining children's motivation through interactive play and immediate feedback, adapting to the cognitive resources of the participants.

On the other hand, Medina Angarita et al. (2019) conducted a study at the Down Syndrome Foundation in the department of Huila, Colombia, to characterize the effect of dynamic assessment on the learning potential of children with intellectual disabilities. The results showed a significant gain in the learning potential of the experimental group compared to the control group. This difference was evident in the typology of correct and incorrect answers recorded after training, where the control group, which did not receive training, presented a higher percentage of incorrect answers. Regarding the pre- and post-training tests, all experimental subjects showed a significant gain compared to the control subjects. The research suggests that these methodologies not only serve to measure performance, but also enable learning, opening new avenues for future professionals interested in investigating the learning potential in people with intellectual disabilities from a neuropsychological-logical perspective.

A study by Arán-Filippetti and Richaud (2011) explored differences in the cognitive style of reflexivity versus impulsivity and in planning ability as a function of social risk. They also evaluated the effectiveness of an intervention program incorporated into curricular tasks in a context of poverty. The results indicated that the intervention programs can be effective in fostering a more reflective disposition, as was observed in the group that received the intervention, which showed a decrease in the number of errors and an increase in latency times, reaching levels similar to the non-risk control group. In terms of planning, it was observed that the children at risk presented a deficit, attributable to the lack of stimulation from the environment and insufficient regulation and verbal interactions on the part of the adults. However, the group that received training showed improvements in both reflexivity and cognitive style, as evidenced by a decrease in errors and an increase in sustaining time.

The executive function plays a crucial role in human cognition, allowing us to initiate, plan, flexibilize, concentrate and monitor the implementation of an action (Lopera, 2008). With the aim of fostering cognitive skills in people with intellectual disabilities, a quasi-experimental study was conducted at the EDISME Training Center for the Mentally Handicapped of the St. Vincent de Paul Society of Medellin. This study focused on computerized training of the planning component of the executive function, using Cogniplus software, in 10 people with a diagnosis of mild intellectual disability, for two months.

In the research, the Labyrinths subtest was used, part of the neuropsychological battery of executive functions and frontal lobes by Flores Lázaro, Julio César; Ostrosky Shejet, Feggy; and Lozano Gutiérrez, Asucena, together with André Rey's Complex Figure test. In Rey's Complex Figure, "the tested subject must copy a complex figure by hand and without time limit" (Pino et al., 2006).

Pre-training results indicated that the hypothesis-generating ability of the tested subjects was compromised due to the nature of the mental representation they used, which prevented them from reaching an abstract level with high flexibility. However, after training, statistically significant changes were observed ($p<0.041$), suggesting that the training favored the performance of each maze and helped to identify errors with greater accuracy. These results demonstrate that it is possible to improve planning performance through a computerized cognitive training program.

Accordingly, it is necessary to study, implement and evaluate cognitive training programs specifically designed to strengthen the planning component of executive function in adults with intellectual disabilities. These programs could use modern techniques, such as interactive software, and offer an effective intervention to improve planning skills, which could potentially lead to improvements in other areas of cognitive function and in the daily lives of adults with mild intellectual disabilities.

METHOD

This was a quantitative study with a quasi-experimental design with pretest and posttest measures in the intervention group. In this study it was not possible to randomize the sample nor was there a control group, which is why it is framed in a quasi-experimental study. The independent variable of the study was the computerized executive functioning training and the dependent variable was the planning ability of adults with mild mental disability. The scope of the study is explanatory in that it seeks to determine the effect of a computerized training program on the planning component in adults with mild mental disabilities.

Participants

By means of a non-probabilistic convenience sampling by reasoned choice, 10 persons between the ages of 18 and 40 years belonging to the EDISME Center for the Mentally Handicapped, of the St. Vincent de Paul Society of Medellin, and who had a clinical diagnosis of mild intellectual disability, without significant motor or sensory compromise, participated in the study. For the selection of the participants, the following were used as inclusion criteria: a documented age between 17 and 40 years, being enrolled in the EDISME center, meeting the diagnostic criteria for mild intellectual disability, according to the Diagnostic and Statistical Manual of Mental Disorders (DSM, V; (American Psychiatric Association, 2014) and accepting and signing the informed consent. The rest of the participants were discarded due to two conditions 1) the IQ test yielded values in a range above 70 and another group of participants in values below 50 and the second condition was the diagnosis many of them had Down syndrome.

Instruments

For the measurement of IQ, the Mexican version **of the WAIS III adult intelligence scale** is used**,** whose central characteristic is to obtain a psychometric measure of IQ in subjects between 16 and 90 years of age**.** This instrument is made up of fourteen subtests, seven belonging to the verbal scale and seven belonging to the manipulative scale. The letters and numbers in the verbal scale and the search for symbols in the manipulative scale are complementary subtests and can be replaced whenever a subject has obtained a deficient score; in this case, the letters and numbers can be replaced by digits and the search for symbols by keys (Wechsler, 1955).

The ***Rey-Osterrieth Complex Figure Test*** was used**,** which evaluates perceptual organization and visual memory in brain-injured individuals through the reproduction of a memory figure after a period of interference (Pino et al., 2006). This instrument measures the ability to organize and plan strategies to solve problems, as well as visoconstructive capacity. The test is administered by asking the participant to copy a complex figure by hand with no time limit. Subsequently, the individual is asked to reproduce the same figure immediately and after 30 minutes, without prior warning and without the help of the original model. This is done with the purpose of evaluating their ability to recall non-verbal material. With norms based on a sample of 332 individuals between the ages of 5 and 70 years, the Rey-Osterrieth Complex Figure Test has demonstrated validity and reliability, with inter-rater reliability coefficients of 0.90 for copying and 0.85 for reproduction after 30 minutes (Pino et al, 2006).

The ***Labyrinths sub-test of the Neuropsychological Battery of Axial Functions and Frontal Lobes (BANFE) (***Lázaro and Solís, 2008) was also used. This test consists of five mazes of increasing difficulty that require progressively more planning to reach the end. It evaluates the individual's ability to respect limits (impulsivity control) and to plan the mental execution to reach a specified goal. This instrument has shown its usefulness in the evaluation of fronto-medial, orbitofrontal (motor control) and dorsolateral (planning) areas. The norms for the BANFE are based on a sample of 450 subjects aged between 6 and 55 years. This test has demonstrated validity and reliability, with an inter-rater reliability coefficient of 0.80 for all measures included in the battery. The BANFE items have high construct validity, supported by neuroimaging and clinical neuropsychology studies. In addition, it has proven to be sensitive in the assessment of a variety of clinical groups, including those with depression, Alzheimer's dementia, vascular dementia, alcohol, marijuana and cocaine abuse, traumatic brain injury, Attention Deficit Disorder in children and adults, and psychopathy (Lázaro and Solís, 2008).

Computerized Training

CogniPlus software, designed by Schuhfried (n.d.), was the tool selected for this study. This software aims to train users in the training and rehabilitation of cognitive functions, including executive function, topographical and working memory, divided, auditory and visual selective attention, combined and visuospatial attention, vigilance, visuomotor coordination, and phasic and intrinsic alertness. CogniPlus has the advantage of adapting to the level and ability of the user, and has proven to be useful in improving mental activation in patients with mild cognitive impairment (Schuhfried, n.d.).

Task used for cognitive training Plan a day - PLAND

For cognitive training, the "Plan a Day" (PLAND) task was used. PLAND presents real planning tasks in a context of daily activities and allows the user to practice exercises of varying complexity. This tool also offers the therapist the opportunity to work interactively with the patient, devising strategies to improve cognitive functions and self-control. In PLAND, the participant must decide the best order to perform the day's activities in virtual streets. The starting point is a list of tasks to be performed in a virtual street, where there are several buildings. The participant must mark the place where he/she is at that moment and plan a route to accomplish a series of objectives, including deciding the order in which he/she will visit the buildings.

The PLAND training program consists of three activities (S1, S2, and S3), with tasks varying according to three types of requirements: observing priorities, minimizing travel time, and maximizing the number of tasks completed. The difficulty levels are gradual and increase in complexity as the objectives of each task are met, with 19 levels for the S1 form of training, 16 for the S2 form, and 28 for the S3 form (Schuhfried, n.d.).

Procedure

Initially, contact was made with the psychologist of the San Vicente de Paul Society, located in the center of the city of Medellín. She provided information about the EDISME Training Center for the Mentally Handicapped, whose students have confirmed diagnoses of intellectual disability. In this institution, a process of sensitization and training was carried out for teachers, managers and families, focused on the study and its possible implications in the daily activities of the students.

Study participants were evaluated by means of a battery of tests composed of

WAIS III, Rey-Osterrieth Complex Figure, and mazes (subtest of the BANFE). These tests were selected to assess the characteristics of the planning component of executive function. For the computerized cognitive training process, CogniPlus software was used.

The training was conducted over 20 sessions of 30 minutes each, distributed in five sessions per week for two months. It was carried out with a group of 10 participants, under the supervision of a trained psychologist. In each session, tasks related to planning were alternatively worked on, complemented with tasks to be performed at home, with the aim of reinforcing the function worked on during the session.

The training program included three activities: 1) observing priorities, with 19 levels of difficulty, 2) minimizing travel time, with 16 levels of difficulty, and 3) maximizing the number of completed tasks, with 28 levels of difficulty. After completing the cognitive training, the neuropsychological test battery (mazes, BANFE subtest and Rey-Osterrieth Complex Figure) was applied again to compare the initial results with those obtained after computerized training.

Ethical considerations

The EDISME Training Center for the Mentally Handicapped (Centro de Entrenamiento para Discapacitados Mentales EDISME) approved and supported the development of the study. We also had the ethical endorsement of the Bioethics Committee of the Universidad de San Buenaventura (Medellín, Colombia) for the application of the instruments and the application of the training program. The informed consent of the participants was signed and the ethical aspects of respect, privacy, non-maleficence and dignity were guaranteed, and confidentiality and anonymity and other ethical aspects established in Resolution 008430 of 1993 of the Ministry of Health (Colombia) were assured.

Statistical Analysis

The results of the application of the evaluation instruments before and after the intervention were systematized in an Excel data matrix. It was verified that there were no missing data. SPSS version 27 statistical software was used for the statistical analyses. Initially, it was evaluated whether the variables complied with the assumptions of normality, which showed that the variables did not have a normal distribution, so nonparametric tests were used to contrast the hypotheses. The Wilcoxon test was used to compare pre-test and post-test scores in the experimental group. To establish statistically significant differences, a $p<0.05$ was used, taking 95% as the level of significance. Finally, the effect size of the statistically significant differences ($p < .05$) reported in the different comparative analyses was estimated. When employing a non-parametric statistical analysis, the eta-squared statistic (n2) was used as a measure of effect size: small effect (0.01), medium effect (0.06) and large effect (0.14) (Phan et al., 2011).

RESULTS

Table 1 shows the results obtained in the performance and execution of the assessment tests.

The results showed an increase in the planning component of the executive function before and after the computational training. Statistically significant differences were found (p<0.008), and a medium effect size (n2= 0.703), in the execution times of the complex king figure, showing an increase in the execution speed after the intervention. Regarding the planning ability, which was measured through the item do not touch and dead-end path of the BANFE subtests (mazes), statistically significant differences were found with <0.465, and respectively with <0.417 showed higher scores in the posttest when compared to pretest scores. No statistically significant differences were found in type of construction, mazes traversed and execution times, showing equality in the two moments of the evaluation.

Table 1.

Pre-test and post-test analysis in the intervention group using the Wilcoxon test.

Complex King Figure	**Pretest**	**Posttest**	***z***	***p***	***n2***
Total Score	24,2	23,6	-,4220	0,673	
Weather	335,5	184,4	-2,652	0,008	0,703
Construction Type	2,3	2,5	-,4470	0,655	
Banfe Labyrinths	**Pretest**	**Posttest**	***z***	***p***	***n2***
Lab.Atrav1	1	0,4	-1,730	0,084	
Cross	1	0,4	-1,730	0,084	
Planning	3	4	-2,041	0,041	0,417
P. Normative					
Weather	296,04	250,8	-1,478	0,139	
Time P. Normative	2,5	3,6	-2,157	0,031	0,465

Table 2 shows the minimum number of sessions performed to complete exercise 1 was 6, the maximum was 14 sessions, all participants reached the maximum number of levels (19); execution times were between 114 seconds and 179 seconds. The maximum percentage of effectiveness was 86%, the maximum number of aids was 2 per task. In task 2 the minimum number of sessions performed was 3, the maximum 7, the maximum level reached was 16, the execution times were between 28 seconds and 97 seconds; the maximum percentage of effectiveness was 78%; the maximum number of aids was 2 per task. In task 3 the minimum number of sessions performed was 2, the maximum was 10, the maximum level reached was 16, the execution times were between 38 seconds and 170 seconds; the maximum percentage of effectiveness was 76%; the maximum number of aids was 1 per task.

Table 2.

Training program

Tasks	**Variables observed**	**M + DE**	**Minimum**	**Maximum**
1	Number of sessions	8,30 + 3,30	6	14
	Level	19	19	19
	Time in seconds	468,30 + 605	114	1791
	Percentage	83+6	70	90
	Help	2+3	3	2

Tasks	Variables observed	M + DE	Minimum	Maximum
2	Number of sessions	4,5 + 1,179	3	7
	Level	15,9 + 0,310	15	16
	Time in seconds	56,8 + 21,545	28	97
	Percentage	61,8 + 8,791	53	78
	Help	2+3	2	1
3	Number of sessions	7,7 + 2,791	2	10
	Level	11,6 + 2,914	7	16
	Time in seconds	69,9 + 36,843	38	170
	Percentage	54,0 + 12,266	33	73
	Help	1+1	1	1

Discussion

Ibáñez et al. (2017) reported that, during the King Figure test, participants paid attention to the instructions, but tended to rotate the sheet vertically in order to solve the activity. It was also observed that female subjects often had difficulties in recognizing some geometric figures.

In our study, the participants' executions in the mazes indicate a commitment in the planning index. As can be seen in Table N. 1, the average performance was located in index 3, which denotes a commitment in the planning processes. Through the analysis of the errors committed, we noticed that the participants managed to understand and maintain the instruction present for the performance of the task, and even conceptualized the task, i.e., they previously thought and ana- lyzed the task for its execution. However, they failed to generate the appropriate hypothesis, reflected in the choice of incorrect paths, although they were able to identify the error and seek a new strategy to successfully complete the task. Only after several errors did they successfully complete the task. This pattern suggests that, for people with cognitive disabilities, learning through trial and error is necessary.

It is important to note that this pattern was repeated in the different mazes, i.e., participants were able to complete one maze, but could not generalize the mental scheme to the next one. Dehaene and Changeux (1997) propose a hierarchical model of planning that may help to explain these results. This model involves the generation of hypotheses, the selection of the means to resolve them, and the evaluation of these hypotheses. These hypotheses depend on prior knowledge and, in the case of cognitively impaired patients, hypothesis generation is compromised, since their mental presentations do not reach abstract and flexible levels of thinking. This difficulty in analysis, synthesis and generation means that the previously developed schemes are not applicable to other similar tasks.

This finding coincides with the study by Aran-Filippetti and Richaud (2011), who proposed to demonstrate the effectiveness of an intervention program to increase reflexivity and planning in a school setting at high risk of poverty. According to Aran, a deficit in self-regulation was observed, with a greater tendency to enter dead-end passages and make more mistakes. However, in contrast to these findings, Danielsson et al. (2010) found no significant differences in terms of self-regulation.

to nonverbal planning ability by comparing adults with intellectual disabilities to a control group.

In our investigation, after the second application of the test battery and after receiving the computerized training, statistically significant changes were observed in terms of the planning index, with a $p<0.041$. This change suggests an increase in scores, which could indicate improvements in hypothesis verification, in addition to prior learning that favored the performance of the different mazes. As the difficulty of the stimulus (maze) progressed, participants identified errors with greater anticipation, such as: traversing, touching, closing the maze without achieving it, and a decrease in solution time.

According to Flores et al. (2008), planning is a process in which a series of sequential actions must be carried out, through which the subject proposes solution options before reaching the goal. It is important to bear in mind that the result is not necessarily obtained in an unmediated manner. This pattern was observed in our participants, especially after computerized cognitive training.

Another instrument used for the assessment of planning was the Rey-Osterrieth Complex Figure Test (2009). This test involves asking the subject to copy a complex figure by hand and with no time limit. It is important to note that the analysis of planning ability was based more on the types of copying and the accuracy of the result than on the total sum of the items. The dis- paigns were classified as follows: type 1: construction on the frame, type 2: details included in a frame, type 3: general outline, type 4: juxtaposition of details, type 5: details on a confusing background, type 6: reduction of outline and type 7: scribbling.

Participants showed difficulties and deficits in the nonverbal planning index. As can be seen in Table 1, the average performance was located in construction type 2. When analyzing the type of construction, it can be observed that participants started with one detail or another, adding, for example, the large rectangle (such as the upper left cross) and others traced the large rectangle by encompassing it or another detail (for example, the outer square next to the lower left corner of the rectangle). No rotation or displacement was observed; the overall figure was correctly placed. No unit was omitted or missing in general, although in two participants it was difficult to recognize the whole figure. As for the size, on average it was adequate and the dimensions were preserved, although in one participant the phenomenon of macrography was observed.

In general, participants were able to understand and keep in mind the instruction to perform the task, but required more time for planning and constructing the figure. Furthermore, it was observed that the processing resources were not sufficient to execute the task adequately, which was noticeable in the construction errors. Here again the phenomenon of adequate hypothesis generation arises: the participants were not able to identify the figure in its entirety and when constructing it they started with the details, when what is intended is that the construction is carried out on the armature in relation to the grouping of the other elements. However, in some participants an adequate construction was observed, which could be explained by the level of schooling and the adequate processing of the information. According to Castañeda and Castañeda (2017), this may be due to an impairment in executive functions, so cognitive intervention should be adjusted and combined with activities of daily living.

After analyzing the results and identifying the deficiencies in planning skills, the cognitive training phase began. For this stage, the COGNIPLUS software was used, and specifically the PLAND (Plan a Day) program, in which the participants had to carry out various real planning exercises based on daily activities of varying complexity.

The score obtained from the cognitive training was expressed in number of sessions, recording the level reached during each session. The execution time for each level, the percentage of efficiency in solving the task, and the number of times the participant used aids to solve the task were also recorded. During the first activity, where the participant, based on the instructions, had to choose a single route due to its importance and priority, it was observed that 9 of the 10 participants needed at least 8 sessions to complete the 19 levels. One participant needed 14 sessions. In terms of execution time, participants required an average of at least 6 minutes to complete each exercise. Only one participant needed more than 15 minutes to complete a task. Regarding the percentage of efficiency, the average participant reached 70% efficiency in completing each task, with only one participant reaching 90% efficiency. Regarding aids, on average, participants used at least 2 aids or visualizations in each task, and only one participant used 3 or more.

In the second task, "Travel Times", which consists of choosing different locations on the map to which the participant must go, taking into account the travel time involved, it was observed that participants needed on average at least 4 sessions to successfully complete the 16 levels. Only one participant needed 7 sessions. In terms of time spent, participants required on average 56 seconds to solve a task, and only one participant needed 97 seconds. Regarding the percentage of efficiency, the average reached 60%, with only one reaching 78%.

Finally, in the third task, it was observed that the number of sessions required to reach level 12 was 7, and only one participant managed to reach level 16. The average time required was 40 seconds per task, while the participant who used the most time needed two minutes per task. As for the percentage of effectiveness, the average was 53%, and only one participant reached 73%. In terms of aids, on average only one aid was used per task. It should be noted that no participant managed to complete all 28 levels of difficulty due to the high degree of analysis and synthesis required for the resolution of each task, which coincides with the specific situation of intellectual disability presented by the participants.

After analyzing the execution of the tasks, we noticed that people with intellectual disabilities were able to read and understand the instructions, familiarize themselves with the task, consider what might be the best options or routes when solving the problem, and sometimes respond correctly to the statement. All of this was achieved through an initial explanation of what they were going to do, followed by a tutorial and some demonstration exercises. Only after several work sessions and multiple corrective feedbacks, the participants began to understand and interpret the instructions better.

That is, before executing the task, the participants carefully read the statement, selected the places they were going to go to, and finally verified whether the choice had been correct before giving the order to start. It is important to emphasize that in the first task the participants were able to prioritizing and ignoring those routes that were not part of the itinerary. In the second task, they quickly identified the distances and time it would take them to get from one place to another.

As for the third task, it was observed that the level of abstraction and analysis of the participants was not sufficiently effective at the time of performing the tasks, so that the level achieved for some was lower than expected. This task requires high levels of analysis, synthesis and hypothesis verification, since the tasks are not always the same and there were constantly changes from one task to another. In addition, the number of tasks increased as they advanced in level.

This is evidence that the thinking schemes in people with intellectual disabilities depend on prior knowledge and constant instruction, where error is checked and the task is adapted for a better solution. This finding is consistent with that found by De La Torre et al. (2017), who describe that, during the implementation of a computerized training program, participants manage to strengthen the planning component to the point that their decisions are more aligned with what is expected. These same authors postulate that people with intellectual disabilities can benefit from this type of training, since this learning can be implemented in their real context.

After the cognitive training, a second application of the neuropsychological tests - the mazes of the BANFE subtest and the King figure - was performed in order to contrast the initial results with the final results after having undergone the computerized training.

The final results regarding the maze and King figure tests can be seen in Table 2. Regarding the planning index (mazes with no exit), statistically significant changes were observed with a <0.041, indicating an increase in the scores. This could suggest changes in the verification of hypotheses and prior learning, which favored the completion of the different mazes. As the difficulty of the stimulus (maze) increased, the participants identified errors more in advance, such as crossing or touching the maze closure without achieving it, and reduced the solution time. These changes could be explained by the findings of Gallardo et al. (2011), which explored the learning potential in a group of children with intellectual disability.

Accordingly, the participants in the present research showed the ability to remain alert, select information, retain it, and continue with the task. Among the strategies to approach the task, they used trial and error, and then devoted time and effort to solve the task again. They were constantly seeking help and approval. The level of help required consisted of hints so that they could reflect and correct errors based on intervention or explanation.

In accordance with the above, García and López (2019), De La Torre et al. (2017) suggest that training programs could be facilitators of the improvement in cognitive skills. Additionally, these authors suggest that this improvement could be enhanced with family accompaniment (López et al., 2019 and De La Torre et al., 2017).

Based on tests that measured execution time, such as the King Complex Figure and one of the planning indices as proposed by the Executive Function Assessment Battery (EFA).

(BANFE), significant improvements were evident. In the King Complex Figure, a statistically significant increase was recorded with a <0.008. In the mazes, corresponding to the BANFE time index, statistically significant changes were revealed with a <0.031. These results indicate that, probably, participants were able to plan and solve the presented tasks more fluently and efficiently after the intervention, processing the information quickly and efficiently. This is consistent with Soprano (2003) and Méndez Mendoza (2010), who suggest that the improvement in planning ability depends on several conditions, including impulse control, an adequate level of memory and the ability to sustain attention, in addition to the learning potential mentioned by Gallardo et al. (2011).

The statistical analysis reflects the participants' ability to self-regulate their behavior, to maintain, select and continue with the task, and to approach it through trial and error. From this type of learning, significant changes in execution time and improvements in the planning index of the maze sub-test (BANFE) were identified.

It is suggested to replicate this study with a larger sample and to use different specific assessment instruments for planning, such as those derived from the Tower of Hanoi, Zoo Map, Porteus' Lintos, and Rings, among others. In addition, it would be beneficial to design an intervention strategy focused on the results of the comparison between the computerized program and paper and pencil tasks. This could provide a more complete picture of the skills and areas of improvement in the participants, and allow the adaptation of interventions to better meet their individual needs.

CONCLUSIONS

The findings of this study indicate that it is feasible to improve performance in planning tasks through computerized training. However, it is essential to remember that these abilities are subject to stimulation, academic processes, adaptive skills, diagnostic status, and the absence of a history of cognitive impairment and/or mental or metabolic disease.

Some students with mild intellectual disabilities showed a deficit in visual-constructive ability prior to cognitive computer training, as reflected in the results of the King Figure test. This deficit was manifested in the performance of the figure in an irregular and disorganized manner. However, after training, 8 of the 10 participants showed significant improvements in this ability, reflected in the reduction of the task execution time. On the other hand, two participants presented significant alterations in viso-constructive ability, which highlights the importance of an adequate delimitation of the population profile in future studies. In this study, participants were selected based on certification and diagnostic evidence provided by a general practitioner, without a specific assessment of their cognitive status.

As for the final results of the maze test, eight participants improved their performance, as evidenced by the decrease in execution time, impulse regulation, task monitoring, analysis, abstraction and sequencing capacity, and, therefore, planning ability. It should be clarified that these results are not entirely conclusive.

more to the study itself and therefore other studies are required to validate or reject this finding.

Therefore, the computerized cognitive training program makes it possible to identify and enhance skills, improving the performance of people with mild intellectual disabilities in daily life. It also makes it possible to determine whether the changes resulting from the training persist over time and to evaluate behavioral modifications after training (e.g., classroom behavior, behavior at home and social role). This is in line with what was proposed by Galvis and Lopera (2018), who stated that different computer platforms and virtual environments can generate high levels of motivation, potentiating and favoring cognitive and learning processes. Following this line, citing Rosselli et al. (2010), they suggested that such condition does not limit learning; rather, an adequate and organized intervention program can facilitate it. Finally, citing García, Carrasco and Juanes Méndez (2013), they concluded that training programs benefit this population since the brain is modified due to exposure to technology and stimulation resulting from repetition in cognitive exercise (Galvis and Lopera, 2018).

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