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# *Training Cognitive Flexibility in the Elderly (Aged 75-80) with an Ecological Approach*

## [*Entrenamiento de la flexibilidad cognitiva en adultos mayores entre 75 y 80 años desde un enfoque ecológico*]

## [*Treinamento de flexibilidade cognitiva em idosos com idade entre 75 e 80 anos a partir de uma abordagem ecológica*]

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***ABSTRACT***

**Introduction**: cognitive flexibility plays a key role in the solution of social problems related to living with the elderly. It helps choose the necessary strategies for adjusting to demanding situations, and to offer more flexible responses.

**Aim**: To evaluate the effectiveness of cognitive flexibility training in 75-80-year-old people, through tasks based on the identification of clues and signals.

**Materials and methods:** The population consisted of 123 seniors, from which a final sample of 64 subjects aged between 75 and 80 years old was selected. The analytical-synthetic theoretical method was used for the theoretical design of this study, while the *TMT A&B (Trail Making Test)* was the empirical method used to evaluate the effectiveness of tasks. A semi-structured interview was included in the research. A critical review of the literature was performed as described in the bibliographic method. The stimulation activities were characterized by a system of tasks that promoted cognitive flexibility by identifying clues and signals in natural conditions.

**Results**: There were statistically significant differences between the scores of the first and second application in the experimental group, according to the Wilcoxon test, and for the independent samples, according to the Mann-Mhitney U test. There was a correspondence between the tasks performed and the demands of cognitive flexibility in the elders that participated in the study.

**Conclusions**: The ecologically-based training program was effective in promoting cognitive flexibility in 75-80-year-old individuals.

**Keywords**: Elderly, cognitive flexibility, cognitive training, ecological approach.

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*RESUMEN*

**Introducción**: la flexibilidad cognitiva tiene un papel relevante en la resolución de problemas en el entorno social de convivencia de adulto mayor. Permite seleccionar las estrategias necesarias para adaptarse a las situaciones demandantes en el ambiente y responder de forma más flexible.

**Objetivo:** evaluar la efectividad de un entrenamiento de la flexibilidad cognitiva en adultos mayores entre 75 y 80 años mediante tareas basadas en la identificación de pistas y señales.

**Materiales y métodos:** la población la constituyeron 123 adultos mayores, de la cual emergió una muestra formada por 64 adultos mayores entre 75 y 80 años. Para la

elaboración teórica se empleó el método analítico-sintético y como método empírico para evaluar la efectividad de las tareas se empleó el *Test del trazo-TMT A&B (Trail Making Test),* así como una entrevista semiestructurada. La revisión crítica del material bibliográfico se realizó mediante el método bibliográfico. Las actividades de estimulación se caracterizaron por un sistema de tareas que potencian la flexibilidad cognitiva mediante la identificación de pistas y señales en condiciones naturales.
**Resultados:** los resultados mostraron diferencias estadísticamente significativas entre las puntuaciones de la primera y segunda aplicación en el grupo experimental según la prueba de Wilcoxon y para muestras independientes según la prueba U de Mann-Whitney. Se logra una correspondencia entre las tareas realizadas y las demandas de la flexibilidad cognitiva del adulto mayor participante.
**Conclusiones:** el Programa de entrenamiento desde un enfoque ecológico demostró ser efectivo para potenciar la flexibilidad cognitiva en el adulto mayor entre 75 y 80 años.

**Palabras clave:** adulto mayor, flexibilidad cognitiva, entrenamiento cognitivo, enfoque ecológico.

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*RESUMO*

**Introdução**: a flexibilidade cognitiva tem papel importante na resolução de problemas no ambiente social de convivência do idoso. Permite selecionar as estratégias necessárias para se adaptar a situações exigentes no ambiente e responder com mais flexibilidade.
**Objetivo**: avaliar a eficácia do treinamento de flexibilidade cognitiva em idosos entre 75 e 80 anos por meio de tarefas baseadas na identificação de pistas e sinais.
**Materiais e métodos**: a população foi constituída por 123 idosos, da qual emergiu uma amostra constituída por 64 idosos com idades compreendidas entre os 75 e os 80 anos. Para a elaboração teórica foi utilizado o método analítico-sintético e como método empírico para avaliar a eficácia das tarefas foi utilizado o Trace Test-TMT A&B (Trail Making Test) e uma entrevista semi-estruturada. A revisão crítica do material bibliográfico foi realizada por meio do método bibliográfico. As atividades de

estimulação foram caracterizadas por um sistema de tarefas que aumentam a flexibilidade cognitiva por meio da identificação de pistas e sinais em condições naturais.
**Resultados**: os resultados mostraram diferenças estatisticamente significativas entre os escores da primeira e da segunda aplicação no grupo experimental segundo o teste de Wilcoxon e para amostras independentes segundo o teste U de Mann-Whitney. Uma correspondência é alcançada entre as tarefas realizadas e as demandas de flexibilidade cognitiva do idoso participante.
**Conclusões**: o Programa de Treinamento de abordagem ecológica mostrou-se eficaz no aumento da flexibilidade cognitiva em idosos entre 75 e 80 anos.

**Palavras-chave**: idoso, flexibilidade cognitiva, treinamento cognitivo, abordagem ecológica.

## *INTRODUCTION*

A special phenomenon of present times is the prolongation of life expectancy in humans, with higher numbers of older adults in society. This population growth derives from the advances in science and technology against diseases and aging-causing factors.

Although the increase of the elderly population worldwide constitutes an achievement, aging may lead to a progressive reduction of physical and cognitive capacities in certain numbers of people, with apparent changes in cognition (Kawasaki et al., 2021), especially those produced in the most complex cognitive functions, which are determinant in the relation with the environment.

In the elderly, one of the critical cognitive functions is the everyday interaction with the environment, known as cognitive flexibility. It permits humans to adapt their cognitive apparatus to changing, new, and unexpected situations, and stimulate proper responses in keeping with environmental demands. Therefore, it comprises a whole repertoire of actions that permits reorienting or changing thinking depending on a demanding situation, for which conduct must be regulated and adjusted to the required solution (Goldberg & Bougakov, 2005; Tirapu-Ustarroz & Luna-Lario, 2008).

Cognitive flexibility is a component of executive functions that contributes to new learning. It is the capacity of mediating the interaction of cognitive processes as a whole, and process or respond to different situations differently and adapted (Eslinger and Grattan, 1993; Cartwright, 2002). It has the capacity of producing diverse ideas, consider response alternatives, and modify behavior and cognition as a response to the changing environmental demands (Uddin 2021).

On the contrary, it creates cognitive rigidity, which is produced when individuals are incapable of recognizing changes in the demands from the environment and use the same strategies though they fail to meet goals. This process shows the lack of identification that the situation is new and calls for the implementation of a new strategy (Cañas *et al.*, 2022).

Along with these results, León (2021) diagnosed a population of 157 elderly, the starting point for this research, and found that functions like work memory, inhibitory control, and cognitive flexibility become more troublesome with age. Cognitive flexibility was found to have a positive correlation with the instrumental activities of daily life, especially between 75 and 80 years of age. Hence, this age range may be critical for the design of interventions that produce positive values of cognitive health in the elderly, and prevent functional absences caused by aging in the future.

Schaie, 2010; Karlsson *et al.*, 2019; Falk Erhag *et al.*, 2021 reported that intermediate aging (70-80-year-old people, approximately) demand a redefinition of the concepts of self-elaboration, thus testing transient identity, since they do not have the prospect possibility of thinking about the future when nothing is withheld in the present. This contradiction makes the older adults minimize a contradiction with the environment, and consequently, they have issues with visuospatial and decision-making that compromise cognitive flexibility (Richard's, *et al.*, 2021; Conte *et al.*, 2022, Lee *et al.*, 2022)

However, despite this negative trend of aging, cognitive flexibility is one of the possibilities of cognitive potential in the elders, considering that the decline of vital conditions throughout life can be changed by means of interventions that mobilize the learning capacity and cognitive plasticity, the key to active aging (Nguyen *et al.*, 2019; Diniz *et al.*, 2022).

Duda & Sweet (2019); Wollesen *et al.* (2020); Smid *et al.* (2020), try to address this issue by stimulating cognitive flexibility through training at different levels under ecological conditions, which comprise the motor component and tasks in enhanced spaces that call for topographic interaction with the environment (Laczó *et al.*, 2017; Herold *et al.*, 2018; Torre & Temprado, *2022*).

The ecological approach as a psychological conception in training settings permits learning improvements with the man-environment interaction and subject-situation problem. It also enables progressive balance of the person toward action, since the corresponding tasks embody psychomotor dynamic, goal consensus, and positive orientation regarding the environment (Eriksson, *et al.*, 2018, Herold *et al.*, 2018).

Temprado, 2021; Torre and Temprado, 2022 said that the ecological approach permits improved cognitive flexibility with an integrative vision, and provides neurocognitive benefits needed to be used in the social dynamic of the elders.

Consequently, this paper focuses on the implementation of cognitive flexibility training under ecological conditions based on the implementation of a system of tasks characterized by the existence of sketches and the identification of clues and signals in natural environments. These training scenarios create conditions so that the participants are capable of translating spatial information to achieve a goal in the shortest time and best possible ways.

Accordingly, this paper aims to evaluate the effectiveness of cognitive flexibility training in subjects aged 75-80, through tasks based on the identification of clues and signals in natural settings.

## *MATERIALS AND METHODS*

This is an experimental research based on a system of tasks to estimate cognitive flexibility in a group of elders with TMT limitations.

The population consisted of 123 older adults, from which a final sample of 64 individuals aged 75-80 was selected. The selection was possible through an intentional non-probabilistic sampling, since the individuals selected should obey the following inclusion and exclusion criteria upon signing the written consent.

The inclusion criteria required elders with cognitive flexibility difficulties who could score positively in the *Minimental State Examination* (*MMSE*).

The exclusion criteria ruled out elders that used medication causing somnolence, or distracted attention, which might affect the execution of tasks. Besides, subjects with some physical issues that might hamper the stimulation of cognitive flexibility tasks.

The tasks were oriented after the sample was distributed randomly in each research group, as described below:

- Experimental group: This group was part of the cognitive flexibility training, *consisting of 32 elders aged* 75.4, on average.
- Control group: This group was not part of the cognitive flexibility training, and consisted of 32 elders aged 75.5, on average.

As described in Figure 1, the study comprised three phases. Phase 1 consisted of an evaluation of cognitive flexibility in the two groups (experimental and control), whose likeness was checked. Phase 2 consisted of the implementation of training tasks for the experimental group. Phase 3 focused on the second measurement, which evaluated the effectiveness of tasks as to cognitive flexibility in the subjects participating, which were compared with the control group (Figure 1).

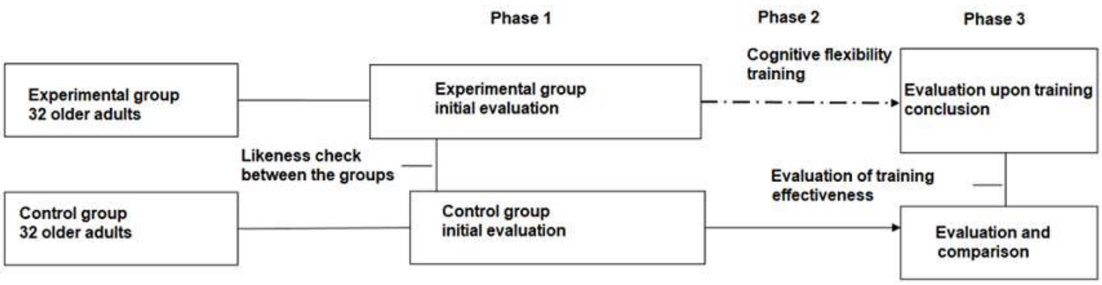


***Fig. 1.*** *- Cognitive flexibility training implementation phases*

The scientific hypothesis of this study suggests training based on identification tasks of clues and signals in natural settings that contributes to enhancing cognitive flexibility in 75-80-year-old individuals.

The following variables were used to check the hypothesis:

Independent variable:

The ecological training of cognitive flexibility constitutes a document with a set of tasks, objectives, contents, methods, means, and procedures that comprise a practical didactic in an everyday setting. Its main feature is to optimize the development of the person or group receiving it. It must adapt to the participants' living standards looking to change the cognitive component trained, particularly, cognitive flexibility. The main method consists of accompanying, instructing, and training the participants to enhance cognitive flexibility through tasks for the identification of clues and signals in everyday settings.

Dependent variable:

Cognitive flexibility: The capacity to change the cognitive scheme fluently, which is required to deal with and address issues depending on routine changes. It comprises the capacities of cognitive control, inhibition of the first automatic response, or the most obvious response, flexible choice changes so that an alternative response to the task variations presented can be produced. It was operationalized through the TMT A&B (*Trail Making Test*), a measurement of processing speed and concentration of an individual's attention.

Control variables:

They comprise the external circumstances that might influence the results of an intervention, so they should be stable throughout the study. Though the researchers did not adjust them, the variables were controlled through observation and record-making in every session. The subjects' ages were taken into account for the control, along with their cognitive health, the state of basic mobility, and the consumption of medication with sedative effects or antidepressives that may interfere with the proper performance of elders during the training sessions.

The analytical-synthetic method was used to elaborate the theory, which helped with the process of information and enabled the conceptual interpretation of the empirical data collected in this study.

The *TMT A&B (Trail Making Test)* was the empirical method used to evaluate cognitive flexibility. The test was designed in two parts (A and B). Part A of TMT consisted of processing and focusing on the speed of the individuals. Part B evaluated cognitive flexibility and alternating attention since it must inhibit the interference produced by the other set of information in the test.

Part A asks individuals to draw a line joining several scrambled numbers (1-25) on a sheet of paper. Part B, in addition to numbers (1-13), introduces the letters of the alphabet (A-L), and the subjects should join the elements by their logical order, alternating numbers and letters. The time of the two parts of the task was not measured, indicating it was supposed to be completed as fast as possible. Each part was calculated separately. The score for each part of the test was the seconds it took the subjects to complete the task.

A non-structured interview permitted the confirmation of the results and enabled feedback from the participants to evaluate their motivational status, the effects of tasks, and their willingness to participate in the training sessions.

The critical review of theoretical information was facilitated by the bibliographic method; it helped with updating and consolidating the main theoretical referents gathered from several different scientific sources and research results.

*Characteristics of ecological training of cognitive flexibility*

The training in cognitive flexibility was done in 20 sessions, which lasted 1 hour and 20 minutes, twice a week, totaling 10 weeks.

Three preparatory meetings were held before the sessions to train the participants for the activities. It also includes the acquisition of symbols used in the sketch to ensure the proper orientation of the subjects (Figure 2).

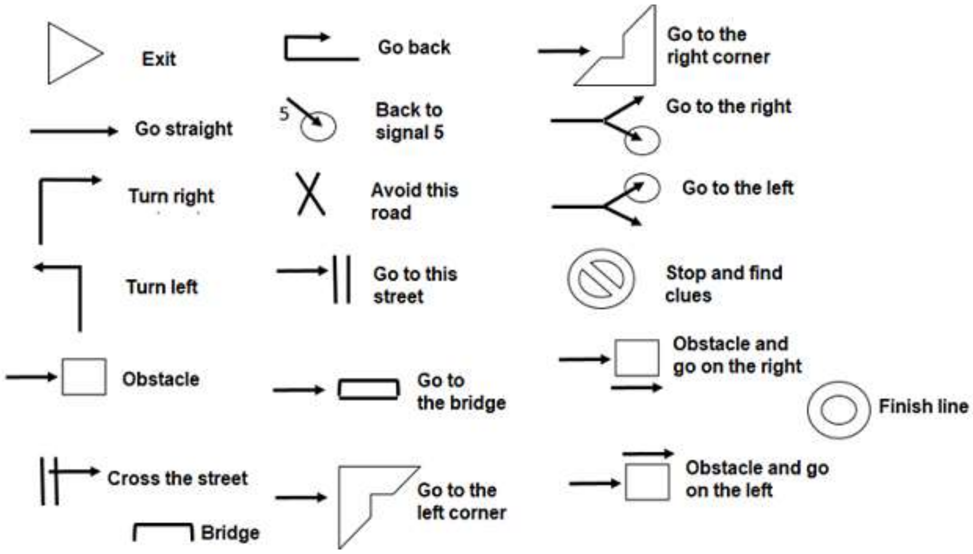


*Fig. 2. - Symbols used to ensure proper sketch handling*

The core of training activities in each session was a sketch given (Figure 3) to each participant or pair. It illustrated the clues and signals previously located in the work area, which the elder must know from previous practices.

The participants should continue their exercise to complete the task and identify the clues in the area and record them, depending on the case based on previously handed-in protocol. Then, the subject's performance is assessed using the clues and signals identified, the quality of the route, and the time elapsed.

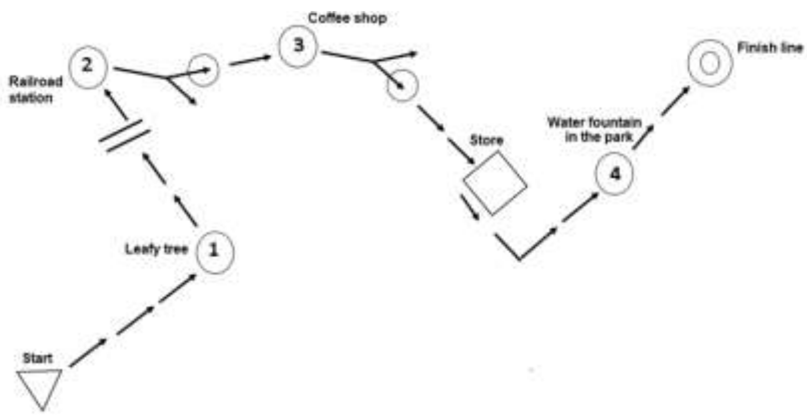


*Fig. 3. - Sample sketch used in the training activities*

Movement through an area searching for clues previously situated in the scenario simulates a usual route taken by the older adults. However, to achieve that goal, the subjects must make the least number of errors and complete them in the shortest possible time. The elderly should be able to design a plan, then observe the surrounding, adapt to the changes, and be flexible enough to identify the clues in the right direction of the route. As the training sessions will become more complex as time advances, with an increase in the number of tracks, executions, area, and sketch design changes.

The data were processed using SPSS (*Statistical Package for Social Science*), version 25, for Windows. The description of the distributions of each variable relied on descriptive statistics through data analysis, such as the mean, minimum and maximum values, and standard deviation. The results were supported by tables and graphs, which helped interpret the database.

The comparison of the TMT A&B (*Trail Making Test*) results was made using non-parametric statistics with the Mann-Whitney U test for dependent tests, as well as the calculation of the effect size among the groups. The Wilcoxon contrast test for the comparison of related and independent samples was used for a 0.05 significance in each case.

The results were checked using the following statistical hypotheses:

1. A statistical hypothesis to check the experimental and control group's equality (independent samples) in the initial results of the TMT A&B (*Trail Making Test*) that evaluated cognitive flexibility.

- Ho: Experimental Group = Grupo Control.
- H1: Experimental group ≠ Control group.

2. A statistical hypothesis to compare TMT A&B (*Trail Making Test*) results, which evaluated cognitive flexibility in dependent samples before and after the training period.

- Ho: before = after.

- (H1: before ≠ after.

3. A statistical hypothesis to evaluate the effectiveness of training of independent samples through TMT A&B (*Trail Making Test*) results, which evaluated the second application of cognitive flexibility.

- Ho: Experimental Group = Control group.
- H1: Experimental group ≠ Control group.

The ethical considerations for the research were put into practice according to the code of international ethical guidelines for research related to human health, laid out by the Panamerican Health Organization (PAHO) and the Council for International Organizations of Medical Sciences (CIOMS), in collaboration with the World Health Organization (WHO), originally published by CIOMS (2016).

In keeping with this research, a written consent document was required, and guideline No. 25 was established for the mitigation of interest conflicts that might take place between the experimental and the control group.

## *RESULTS AND DISCUSSION*

At the beginning of the research, no statistically significant differences were observed between the statistics of the experimental group and the control group in the initial results of the TMT A&B (*Trail Making Test*). The Ho was not rejected (Ho: Experimental group = Control group), with a $0.399 \geq 0.05$, according to the Mann-Whitney U test for independent tests.

Upon the implementation of the cognitive flexibility training session, the results of the first and second measurements in the experimental group were compared; there were changes associated with cognitive flexibility in all the parts of the test. A comparison of the data from parts A and B at each moment of the test showed a reduction in the time of task execution (Table 1).

***Table 1**. - Statistical distribution of the TMT A&B in the experimental group*

| statisticians | first measurement | | second measurement | |
|---|---|---|---|---|
| | Part A | Part B | Part A | Part B |
| **Half** | 213 | 366 | 213 | 368 |
| **Typical deviation** | 30,932 | 32,429 | 32,963 | 31,375 |
| **Minimum** | 164 | 310 | 148 | 312 |
| **Maximum** | 272 | 418 | 271 | 418 |
| **No.** | 32 | 32 | 32 | 32 |

For instance, in the first evaluation of part A (Figure 4), the mean was 203 seconds, with an SD of 32.807. The top values recorded were 272 seconds with the shortest times recorded at 162 seconds. In part B, the times improved compared to part A; the mean was 151 seconds, with an SD of 19.968. The top values recorded were 183 seconds with the shortest times recorded at 120 seconds.

Likewise, in part B (Figure 4), the results showed significant changes in terms of cognitive flexibility in the experimental group that took the training program. In this case, the values of the first evaluation of part B showed a mean of 357 seconds and a standard deviation of 33.051, with top and lowest values of 418 and 304 seconds, respectively. In the second evaluation, the mean was 261 seconds with a standard deviation of 34.656, and the top and lowest values of 341 and 212 seconds, respectively.

A comparison of these results, as described in Figure 4, using the non-parametric Wilcoxon test for related samples, showed statistically significant differences in the first and second evaluations, both in part A and part B, since $p < 0.05$ in all the cases.

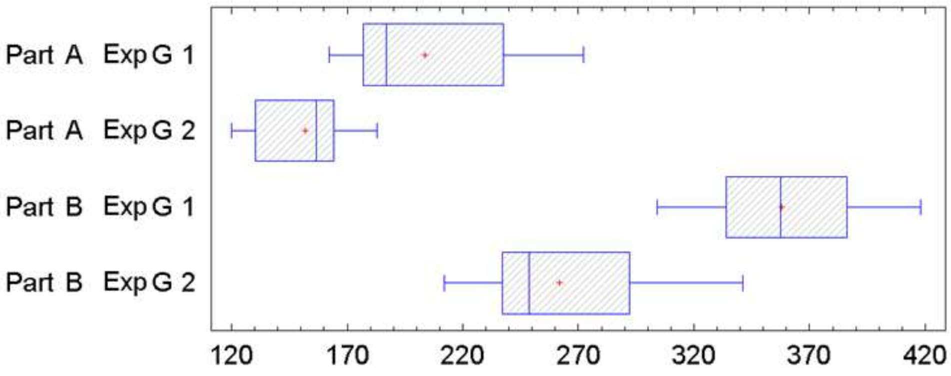


***Fig. 4**. - Results of Wilcoxon non-parametric test for comparison of non-related samples in the experimental group*

The outcomes in the two parts (A and B) caused the rejection of Ho and demonstrated the effectiveness of the program on the behavior of cognitive flexibility since the Wilcoxon non-parametric test showed statistically significant differences in the evaluation of TMT A&B (*Trail Making Test*) before and after the implementation of the program in the experimental group.

The changes made in the experimental group enabled the elders to cope with different situations and adapt easier to the environmental changes, with greater self-control, decision-making, and time management to perform the executive tasks.

The results of the first evaluation of the TMT A&B test in the control group (Table 2) unveiled that part A showed a mean of 213 seconds, and a standard deviation of 30.932, with minimum and maximum values between 164 and 272 seconds. The second implementation of part A showed very stable results, a mean of 213, and a standard deviation of 32.963. The minimum and maximum values averaged 148-271 seconds.

***Table 2**. - Statistical distribution of TMT A&B in the control group*

| statisticians | first measurement | | second measurement | |
|---|---|---|---|---|
| | Part A | Part B | Part A | Part B |
| **Half** | 203 | 357 | 151 | 261 |
| **Typical deviation** | 32,807 | 33,051 | 19,968 | 34,656 |
| **Minimum** | 162 | 304 | 120 | 212 |
| **Maximum** | 272 | 418 | 183 | 341 |
| **No.** | 32 | 32 | 32 | 32 |

In part B (Table 2), the first evaluation showed a mean of 366 seconds, and a standard deviation of 32.429, with minimum and maximum values between 310 and 418 seconds, respectively. Meanwhile, in the second evaluation, the mean was higher (368 seconds) with a standard deviation of 31.375, and top and lowest values of 312 and 418 seconds, respectively.

A comparison of the results of the two measurements in part A figure 5 according to the Wilcoxon non-parametric test, showed that the results of part A in the control group had no significant differences as to the TMT averages. Since p > 0.05, Ho was not rejected according to part A results in the control group (Figure 5).

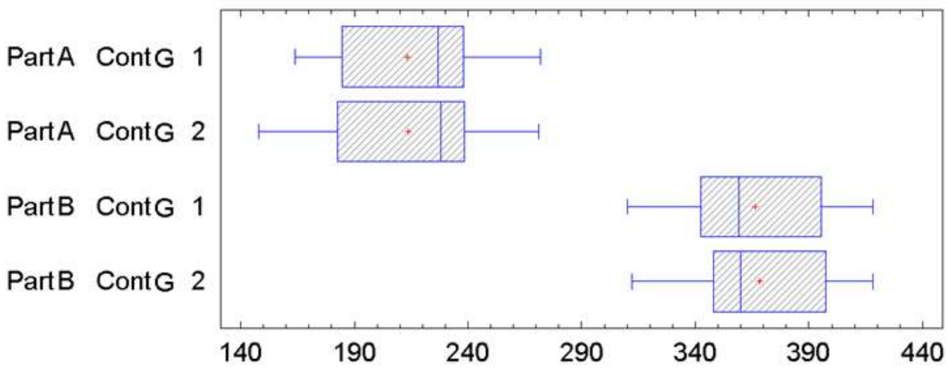


***Fig. 5**. - Results of Wilcoxon non-parametric test for comparison of related samples in the control group*

Likewise, the comparison of the results of the two measurements in part B (Figure 5) according to the Wilcoxon non-parametric test (p > 0.05), had no statistically significant differences concerning TMT averages. Hence, Ho was not rejected for the B copy of the control group.

The outcomes from the comparison between the experimental and control groups were presented to further study the evaluation of cognitive flexibility.

A comparison of part A of TMT in the second implementation for independent groups (experimental and control), according to the non-parametric Mann-Whitney U test for independent samples (Figure 6), showed statistically significant differences in the evaluation of the second measurement upon the program implementation. Being $p < 0.05$, it meant the rejection of Ho, with a big effect size, since r=0.7. Therefore, the effectiveness of the program in terms of cognitive flexibility measured in part A was demonstrated.

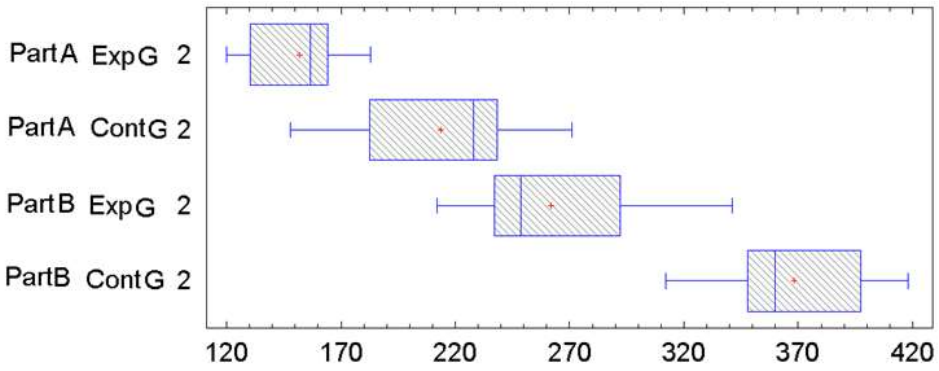


***Fig. 6***. - *Statistical significance of the outcomes of TMT (Parts A and B) for independent samples, according to the non-parametric Mann-Whitney U test*

A comparison of part B of TMT in the second implementation of the groups (experimental and control), according to the non-parametric Mann-Whitney U test for independent samples, showed statistically significant differences in the evaluation of the second measurement upon the program implementation ($p < 0.05$).

The results of the comparison of part B of TMT between the experimental and control groups in the second measurement rejected the null hypothesis (Ho), with a big effect size (r=0.8). Therefore, the effectiveness of the program in terms of cognitive flexibility measured in part B was demonstrated.

The results of this research demonstrated that the training sessions through clue and signal identification in natural conditions led to a favorable effect on cognitive flexibility, as the participants who completed the tasks were able to provide the best responses in the least possible time, and could minimize errors while working on the tasks.

Similarly, Cordes *et al.,* (2019); Wollesen *et al.* (2020), demonstrated that somewhat complex cognitive training by multitasking in everyday spaces permits the mobilization of cognitive resources, which are transferred into better cognitive flexibility in the elderly.

Likewise, reports made by Mack *et al.* (2022) demonstrated that multitasking that combines the cognitive and motor aspects allowed the elderly to learn new skills and develop compensation mechanisms in addition to the ones they had.

Spatial surfing tasks in virtual settings that simulate natural scenarios were mentioned by (McLaren-Gradinaru, *et al.,* 2020; Pawlaczyk *et al*., 2021; Makmee & Wongupparaj, 2022), who implemented a system of tasks that required spatial orientation and cognitive flexibility through complex tasks based on reference points. This allowed the elderly to learn new skills, and develop compensation mechanisms in addition to the ones they had, as well as the capacity of making mental representations of the spatial setting.

This paper replaces the virtual setting with natural scenarios of everyday life for the elderly. The tasks based on the identification of clues and signals were useful to model the everyday demands of cognitive flexibility more efficiently.

Hence, it can be inferred that the results observed in the experimental group showed a better capacity to inhibit stimuli, greater cognitive flexibility and adjustment, and higher motor response speed in the face of complex stimuli, which require a discriminating response, than in the control group.

Cognitive flexibility training was helpful to enhance the mechanisms needed for the acquisition of less biased information in the brain areas involved in stimuli responses from the environment. The tasks developed conditioned the capacity for self-observation and meta-cognition to provide more flexible responses detached from the automaticity of top-down processing.

The elders that took part in the training demonstrated improved adjustment to tasks, which allowed them to practice afferent synthesis as an inherent part of cognitive flexibility mechanisms occurring in psychomotor performance that demands visuospatial control when performing activities.

The scientific hypothesis of this study suggests a training based on identification tasks of clues and signals in natural settings has been demonstrated to enhance cognitive flexibility in 75-80-year-old elders.

On the other hand, there are a series of limitations that might affect the generalization of the research results in other scenarios. These will be mainly related to the fact that this practice requires physical and psychological efforts, and therefore, new methodological adjustments compatible with the subjects in the study. Moreover, it includes learning sessions that create basic conditions ensuring the instrumental component and training systematicity.

## *CONCLUSIONS*

The implementation of tasks based on the identification of clues and signals in natural conditions was effective for cognitive flexibility training in 75-80-year-old elders.

## *BIBLIOGRAPHIC REFERENCES*

Cañas, M., Perea, M. V., & Ladera, V. (2022). Memoria de trabajo, control inhibitorio y flexibilidad cognitiva en pacientes con diferentes grados de severidad en la Enfermedad de Alzheimer. *Revista Argentina de Ciencias del Comportamiento*, 14(2), pp. 49-63. https://revistas.unc.edu.ar/index.php/racc/article/view/30675

Cartwright, K. B. (2002). Cognitive development and reading: The relation of reading specific multiple classification skill to reading comprehension in elementary school children. *Journal of Educational Psychology*, 94(1), pp. 56-63. https://eric.ed.gov/?id=EJ644664

Conte, F. P., Okely, J. A., Hamilton, O. K., Corley, J., Page, D., Redmond, P., Taylor, A. M., Russ, T. C., Deary, I. J., & Cox, S. R. (2022). Cognitive Change Before Old Age (11 to 70) Predicts Cognitive Change During Old Age (70 to 82). *Psychological Science*, *33*(11), pp. 1803-1817. https://doi.org/10.1177/09567976221100264

Cordes, T., Bischoff, L. L., Schoene, D., Schott, N., Voelcker-Rehage, C., Meixner, C., Appelles, L. M., Bebenek, M., Berwinkel, A., Hildebrand, C., Jöllenbeck, T., Johnen, B., Kemmler, W., Klotzbier, T., Korbus, H., Rudisch, J., Vogt, L., Weigelt, M., Wittelsberger, R., Zwingmann, K., Wollesen, B. (2019). A multicomponent exercise intervention to improve physical functioning, cognition and psychosocial well-being in elderly nursing home residents: a study protocol of a randomized controlled trial in the PROCARE (prevention and occupational health in long-term care) project. *BMC Geriatrics*, *19*(1), pp. 369. https://doi.org/10.1186/s12877-019-1386-6

Diniz, C.R.A.F. & Crestani, A.P. (2022). The times they are a-changin': a proposal on how brain flexibility goes beyond the obvious to include the concepts of "upward" and "downward" to neuroplasticity. *Molecular Psychiatry*,28(1): pp. 977-992. https://www.nature.com/articles/s41380-022-01931-x

Duda, B.M., & Sweet, L.H. (2019). Functional brain changes associated with cognitive training in healthy older adults: A preliminary ALE meta-analysis. *Brain Imaging and Behavior*, 14(9), pp. 1-16. https://pubmed.ncbi.nlm.nih.gov/30900077/

Eriksson, M., Gazinour, M., & Hammarstrom, A. (2018). Different uses of Bronfenbrenner's ecological theory in public mental health research: what is their value for guiding public mental health policy and practice? *Soc Theory Health*, 16(1), pp. 414-433. https://doi.org/10.1057/s41285-018-0065-6, https://link.springer.com/article/10.1057/s41285-018-0065-6

Eslinger, P. J. & Grattan, L. M. (1993). Frontal lobe and frontal striatal substrates for different forms of human cognitive flexibility. Neuropsychology, 31(1), pp. 17-28. Frontal lobe and frontal-striatal substrates for different forms of human cognitive flexibility - ScienceDirect https://pubmed.ncbi.nlm.nih.gov/8437679/

Falk Erhag, H., Wetterberg, H., Johansson, L., Rydén, L., & Skoog, I. (2021). Activities of daily living (ADL) and instrumental activities of daily living (IADL) disability in Swedish 85-year-olds born three decades apart-findings from the H70 study.*Age and Ageing*, *50*(6), pp. 2031-2037. https://doi.org/10.1093/ageing/afab112.

Goldberg, E. & Bougakov, D. (2005). Neuropsychologycal assessement of frontal lobe dysfunction. *The Psychiatric clinics of North America*, *28*(3), pp. 567-579. https://doi.org/10.1016/j.psc.2005.05.005

Herold, F., Hamacher, D., Schega, L., & Müller, N.G. (2018) Thinking While Moving or Moving While Thinking Concepts of Motor-Cognitive Training for Cognitive Performance Enhancement. *Frontiers in Aging Neuroscience*, 10(228), pp. 1-11. Doi: 10.3389/fnagi.2018.00228,
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6089337/

Karlsson, P., Thorvaldsson, V., Skoog, I., & Johansson, B. (2019) What can we Expect of Cognition after 70? Cognitive Decline, Stability, and Gain between 70 and 79 Years in Three Swedish Birth Cohorts. Journal of Gerontology & Geriatric Medicine, 5(027), pp. 1-6. https://www.heraldopenaccess.us/openaccess/what-can-we-expect-of-cognition-after-70-cognitive-decline-stability-and-gain-between-70-and-79-years-in-three-swedish-birth-cohorts

Kawasaki, S., Kujawska, A., Perkowski, R., Androsiuk-Perkowska, J., Hajec, W., Kwiatkowska, M., Skierkowska, N., Husejko, J., Bieniek, D., Newton, J.L, Morten, K.J, Zalewski, P., & Kedziora-Kornatowska, K. (2021). Cognitive Function Changes in Older People. Results of Second Wave of Cognition of Older People, Education, Recreational Activities, Nutrition, Comorbidities, functional Capacity Studies (COPERNICUS). *Frontiers in Aging Neuroscience,*13(653570), pp. 1-13. Doi: 10.3389/fnagi.2021.653570, https://pubmed.ncbi.nlm.nih.gov/34025391/

Laczó, J., Andel, R., Nedelska, Z., Vyhnalek, M., Vlcek, K., Crutch, S., Harrison, J., & Hort, J. (2017). Exploring the contribution of spatial navigation to cognitive functioning in older adults. *Neurobiology of aging*, *51*(1), pp. 67-70. https://doi.org/10.1016/j.neurobiolaging.2016.12.003

Lee, B., Cai, W., Young, C. B., Yuan, R., Ryman, S., Kim, J., Santini, V., Henderson, V. W., Poston, K. L., & Menon, V. (2022). Latent brain state dynamics and cognitive flexibility in older adults. *Progress in neurobiology*, *208*(1), pp. 1-32. https://doi.org/10.1016/j.pneurobio.2021.102180.

León Bravo, O. (2021). *Estudio de las actividades instrumentales de la vida cotidiana y las funciones ejecutivas en poblaciones de adultos mayores*. Poster presentado en el IX Congreso Nacional de Extensión y VIII Jornadas de Extensión del Mercosur. Universidad Nacional del Centro de la Provincia de Buenos Aires (UNICEN), Argentina.

Mack, M., Stojan, R., Bock, O., & Voelcker-Rehage, C. (2022). Cognitive-motor multitasking in older adults: a randomized controlled study on the effects of individual differences on training success. *BMC geriatrics*, *22*(581), pp. 1-16. https://doi.org/10.1186/s12877-022-03201-5 .

Makmee, P., & Wongupparaj, P. (2022) Virtual Reality-based Cognitive Intervention for Enhancing Executive Functions in Community-dwelling Older Adults. *Psychosocial Intervention*, 31(3) pp. 133-144. https://journals.copmadrid.org/pi/art/pi2022a10

McLaren-Gradinaru, M., Burles, F., Dhillon, I., Retsinas, A., Umiltà, A., Hannah, J., Dolhan, K., & Iaria, G. (2020) A Novel Training Program to Improve Human Spatial Orientation: Preliminary Findings. *Frontiers in Human Neuroscience*. 14(5), pp. 1-11. *doi: 10.3389/fnhum.2020.00005.* https://www.frontiersin.org/articles/10.3389/fnhum.2020.00005/full

Nguyen, L., Murphy, K., & Andrews, G. (2019). Cognitive and neural plasticity in old age: a systematic review of evidence from executive functions cognitive training. *Ageing Research Reviews*, 55(1): pp. *1568-1637.*https://pubmed.ncbi.nlm.nih.gov/31154013/

Organización Panamericana de la Salud (OPS) y Consejo de Organizaciones Internacionales de las Ciencias Médicas (CIOMS). (2016). Pautas éticas internacionales para la investigación relacionada con la salud con seres humanos. CIOMS. Ginebra 2016. https://iris.paho.org/handle/10665.2/34457

Pawlaczyk, N., Szmytke, M., Meina, M., Lewandowska, M., St²epniak, J., Ba³aj, B., & Dreszer, J. (2021). Gait Analysis under Spatial Navigation Task in Elderly PeopleA Pilot Study. *Sensors*., *21*(1),1-12. https://doi.org/10.3390/s21010270

Richard's, M. M., Krzemien, D., Valentina, V., Vernucci, S., Zamora, E. V., Comesaña, A., García Coni, A., & Introzzi, I. (2021). Cognitive flexibility in adulthood and advanced age: Evidence of internal and external validity. *Applied neuropsychology. Adult*, *28*(4), pp. 464-478. https://doi.org/10.1080/23279095.2019.1652176

Schaie, K.W. (2010) Adult cognitive development from a lifespan developmental perspective. Annual Report of Meiso University, 28(1), 2pp. 1-35. https://sls.psychiatry.uw.edu/wp-content/uploads/2020/03/Adult-Cognitive-dev-from-lifespan.2010.pdf

Smid, C. R., Karbach, J., & Steinbeis, N. (2020). Toward a Science of Effective Cognitive Training. *Current Directions in Psychological Science*, *29*(6), pp. 531-537. https://doi.org/10.1177/0963721420951599

Temprado, J.J. (2021). Can Exergames Be Improved to Better Enhance Behavioral Adaptability in Older Adults? An Ecological Dynamics Perspective *Frontiers in aging neuroscience,*13, (670166),1-9. doi: 10.3389/fnagi.2021.670166. https://www.frontiersin.org/articles/10.3389 /fnagi.2021.670166/full

Tirapu Ustárroz, J. & Lario, P.L. (2011). *Neuropsicología de las funciones ejecutivas.* Manual de neuropsicología. Barcelona: Viguera. https://www.redalyc.org/pdf/727/72712496009.pdf

Torre, M.M., & Temprado, J.J. (2022) A Review of Combined Training Studies in Older Adults According to a New Categorization of Conventional Interventions.*Frontiers in Aging Neuroscience. ,13(1), pp. 1-18.* https://www.frontiersin.org/articles/10.3389/fnagi.2021.808539/full

Uddin, L.Q. (2021). Cognitive and behavioural flexibility: neural mechanisms and clinical considerations. *Nature Reviews Neurosciences***,** 22(1), pp. 167.179. https://doi.org/10.1038/s41583-021-00428-w

Wollesen, B., Fricke, M., Jansen, C. P., Gordt, K., Schwenk, M., Muehlbauer, T., Morawietz, C., Kruse, A., & Gramann, K. (2020). A three-armed cognitive-motor exercise intervention to increase spatial orientation and life-space mobility in nursing home residents: study protocol of a randomized controlled trial in the PROfit project. *BMC Geriatrics*, *20*(1): pp. 1-15. https://doi.org/10.1186/s12877-020-01840-0.

Wollesen, B., Wildbredt, A., van Schooten, K., Lim, M.L., & Delbaere, K. (2020). The effects of cognitive-motor training interventions on executive functions in older people: a systematic review and meta-analysis. *European Review of Aging and Physical Activity*. 17(1), pp. 1-22. https://pubmed.ncbi.nlm.nih.gov/32636957/

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The authors declare having competing interests.

*Author contribution statement*:

The authors have participated in the redaction of the manuscript and the documentary review.