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ORIGINAL

EFFECTS OF A PERCEPTUAL-MOTOR PROGRAMME ON REACTION RESPONSE OF ELDERLY PEOPLE

EFFECTOS DE UN PROGRAMA PERCEPTIVO-MOTOR EN LA RESPUESTA DE REACCIÓN EN MAYORES

Granda-Vera, J.¹; Barbero-Alvarez, J.C.² & Cortijo-Cantos, A.³

¹ Doctor of Physical Education. Permanent Professor at the Department of Music, Plastic and Body Expression Teaching, University of Granada, Spain, jgranda@ugr.es

² Doctor of Physical Education. Full-time Assistant Professor at the Department of Physical and Sports Education, University of Granada, Spain, jcba@ugr.es

³ Degree in Psychopedagogy, Spain, adisl_cc@hotmail.com

Spanish-English translators: Esther Cruz Santaella escruzs@gmail.com

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ABSTRACT

According to several studies, physical activity can reduce the reaction time of elderly people (Hunter et al., 2001) and even make it equal to that of young people (Light et al., 1996). This project included 52 men and women from the City of Melilla distributed in two groups of study: a Control Group (n=26; M=68, 56 years old) taking part in generic physical activities, and an Experimental Group (n=26; M=67, 32 years) undertaking these same activities and also a specific training programme designed to improve balance, postural adjustment and reaction time. The results do not show significant differences either in the post-test or in the transfer test. However, the subjects from the experimental group achieved better performances on the two study variables (simple reaction time or sRT and initial movement time iMT) (**EG** sRT M=.55; iMT M=.53; **CG** sRT M=.60; iMT M=.64). In the per-subgroup analysis, the women of the 60-70-years-old subgroup who participated in the programme obtained significant better results than the subjects of the other subgroups.

KEY WORDS: Response time, Sensory-motor program, Quality of life, Elderly people

RESUMEN

Diversos trabajos han mostrado que se puede reducir el tiempo de reacción en los mayores con la práctica de actividad física (Hunter et al., 2001) e incluso igualar al de los jóvenes (Light et al., 1996). 52 hombres y mujeres de la ciudad de Melilla distribuidos en dos grupos de estudio: un grupo control (n=26 ; M= 68,56 años) que participa en actividades físicas genéricas y un grupo experimental (n=26 ; M=67,32 años) que ha participado en las mismas actividades más un programa de entrenamiento específico para la mejora del equilibrio, ajuste postural y tiempo de reacción. Los resultados no muestran diferencias significativas en el posttest ni en la prueba de transferencia, pero los sujetos del grupo experimental alcanzan mejores desempeños en las dos variables de estudio (Tiempo de reacción simple - TRs y tiempo de inicio del movimiento - TIm) (**GE** TRs M= .55 ; TIm M=. 53 ; **GC** TRs M=.60 ; TIm M=. 64). Por subgrupos de estudio, las mujeres del subgrupo 60-70 años participantes en el programa obtuvieron resultados significativamente mejores que el resto de subgrupos considerados.

PALABRAS CLAVES: Tiempo de Respuesta, Programa sensorio –motor, Calidad de Vida, Mayores

INTRODUCTION

The age-related decline in cognitive functions has been reported in several studies. However, recent findings suggest that this can be also influenced by environmental factors (Kramer, Bherer, Colcombe, Dong & Greenough, 2004), while indicating that regular physical activity is one crucial component of an active lifestyle linked to preserving these functions with aging, so it becomes one key element of anti-aging interventions. The data show the positive effects of this factor on all levels and functions of a subject, in general and specific terms; moreover, this also confirms the results of studies with elderly people which prove that maintaining a high level of aerobic condition is related to good cognitive performances on tasks measuring the attention and executive functions (Colcombe & Kramer, 2003). All these data support the idea that physical activity can improve control aspects of cognition (Hall, Smith & Keele, 2001), an assertion consistent with the results of an analysis of interventions in people over 60 years old during the last decade (Colcombe & Kramer, 2003; Etnier et al., 2006).

Therefore, the physical activity programmes for elderly people must be added to the others intervention strategies. We should understand that the systematic practice of a physical activity programme requires that the subject acquire and keep new habits, so it is crucial to understand and arrange the psychological factors linked to these programmes in order to optimize them. The positive effects of a physical activity programme on elderly people, or against aging, depends on the persistence and continuance of the programme in the long term (Rosenfeld, 1985; Blair y Brodneý, 1999).

Several epidemiological studies have showed a strong interrelationship between the regular practice of physical exercise and an increase of life expectancy. According to some longitudinal and transversal researches developed in Finland (Sarna, Sahi, Koskenvuo & Kaprio, 1993) or the United States and Holland (Bortz, 1991), there is a positive relation between exercise and life expectancy, especially regarding the fact that people practicing physical activity keep health indexes until the end of their life. In tune with these authors, Christensen, Payne, Wughalter, Yan, Henehan & Jones (2003) point out that a lifestyle marked by regular physical activity will reduce the age-related neuromuscular declines; in other words: doses of physical activity could relieve the declines of sensory input and motor performance during simple and select discriminations.

The reaction response –which has the reaction time (RT) as a component– is a traditional measure in the psychological field and can give information about the different behavioural processes: Perception, Decision-making, Anticipation, Memory and Attention (Oña, 1994). The Reaction Time (RT) is “the time elapsed between the application of the stimulus and the execution of the appropriate motor

response" (Alves, 1990: 72); several tasks regarding RT have been profusely used to assess the relations between physical activity and cognitive performance.

In this construct, there are different kinds of reaction time:

- sRT (simple reaction time), defined as the application of a single stimulus for which there is a default response.
- cRT (choice reaction time), defined as the time elapsed between the application of one stimulus out of several choices with a response assigned to only one of them.

In an attempt to analyse the relevance of the reaction response, it can be proved that this variable is an essential component of the execution of multiple activities, even in daily life, understanding it as the velocity of information processing, the decision-making and the start of the action.

According to Alves (1985:35), it seems that the nerve conduction velocity cannot be significantly improved. This leads to conclude that, taking into account the different stages of information processing, the improvement of RT occurs at the core analysis and decision level, the so-called "perceptual time". Therefore, the effects of training will be more efficient at this level. At this regard, Bard & Fleury (1976) state that the time needed to recognise and interpret a stimulus is considerably reduced through practice.

In relation to this construct, ageing usually comes with an increment of sRT values, especially the cRT, where the central nervous system must inhibit the wrong responses while activating the right one for the given stimulus (Yordanova et al., 2004). Moreover, it has been proved that the decline of the cRT starts at younger ages than the deficiencies in the sRT performance (Der & Deary, 2006; Luchies et al., 2002). The influence of practicing physical-sports activity on the reaction time has been studied in "normal" populations, and it seems to be clear that sports practice allows to shorten the time elapsed between the application of an stimulus and the response to it (Whiting, 1979; Alves, 1990; Tavares, 1993). Several works have showed that the reaction time can be reduced in elderly people by practicing physical activity (Hunter, Thompson & Adams, 2001). Clarkson-Smith & Harley (1990) compared the performance of active and sedentary elderly people (55-91 years old) and found that the active subjects achieved faster responses than the sedentary ones in both the sRT and the cRT.

Renaud, Bherer & Maquestiaux (2010) developed a study in which the experimental task allowed to measure the reaction time and the initial movement time. The results confirm the influence of age in the sRT skill, although the differences were significant only in the cRT tasks. Moreover, there was a relevant interaction between the physical condition and the age levels regarding the movement times; the subjects in poor aerobic condition showed the lowest values.

Additionally, a systematic physical exercise can make the reaction time of elderly people equal to that of youth (Light et al., 1996). Nevertheless, the age-related differences in performance are notably smaller on tasks requiring less executive control (Kramer et al., 2000). According to some data, moderate and high levels of physical activity can have positive effects on the cognitive decline.

Christensen et al. (2003) developed a study with 3 groups of elderly people: a group doing vigorous physical activity, a group doing moderate physical activity and a group of subjects practicing no physical activity at all. The results showed significantly better sRT in the subjects of the vigorous group, while there were no main differences between the groups regarding the cRT; however, the vigorous group had better performances.

In a closer context, León, Oña, Ureña, Bilbao & Bolaños (2011) developed a study with 72 women from the Spanish province of Granada. They concluded that taking part in physical activity programmes has a positive effect on the reaction response (sRT); it is necessary to determine which kind of physical activity programme gets the best performances on this behavioural construct.

At this regard, Gálvez (2008) studied the results of the women in his study to compare a group subject to a programme of activities focused on improving the RT (experimental group) and a group with a programme of aerobic physical activity (control group), finding relevant differences just in the experimental group. This and other studies (Ball et al., 2002; Willis et al., 2006) suggest that the lowering of RT values could mainly depend on cognitive-motor factors such as perception, attention and motor memory, so the physical activity programme should have as main content the stimulation of these cognitive processes.

Based on these data, the henceforth-described study has as main goals:

- Checking the distinguishing effects of a physical activity programme (with contents that stimulate behavioural aspects aimed to improve processes such as sensation-perception, reaction response and motor response processes) on the simple reaction time, the initial movement time and the choice reaction time.
- Determining possible differences of influence within the programme according to gender.
- Assessing the effects of the programme on the eldest subgroup that takes part in the study.

MATERIAL AND METHOD

Sample

The participants were 52 men and women from the City of Melilla (Spain) distributed in two groups of study: a control group, with 26 subjects participating in general physical activities such as dance, keep-fit exercises, etc. ($M=68.56$ years old; $SD=4.95$), and an experimental group, with 26 subjects taking part in the same activities and, during intervention, also in the training programme ($M=67.32$ years old; $SD=6.53$).

All subjects were informed about the study purposes and the programme to be developed, and they all gave their written informed consent before the beginning of the study.

Variables and design

The experimental design consisted of two groups, with pre-post measures and a transfer test.

The independent non-experimental variables were gender and age. The independent experimental variable was the kind of physical activity practice of each subject, with two levels: participation and nonparticipation in a programme of sensory-motor stimulation.

The dependent variable was the reaction response, measured through the simpler reaction time (sRT) and the initial movement time (iMT) to light stimuli at the end of the intervention period (post-test), and the choice reaction time (cRT) and the initial movement time to sound stimuli during the transfer test.

Tools

The recording system used to measure the reaction response was “Pheripherix”, designed and developed by Granda and co. (2004) and consisting of: 1 core unit that randomly apply visual and sound stimuli, recording the responses through a photoelectric cell to determine the subject’s reaction time; 2 contact pads to determine the initial movement time; and 1 button to determine the movement time (see Figure 1).



Figure 1. "Pheripherix" system used to assess the reaction response to visual (lights and/or geometrical shapes) and sound stimuli

Process

Before introducing the intervention programme, the participants performed, on an informed and volunteer basis, the test involving the simple motor reaction response to light stimuli. They received 20 light stimuli randomly applied through several led-lights located on tripods along the whole visual angle; the participants must initiate their motor response after the application of the stimuli. We measured the reaction time and initial movement time values (see Figure 2).

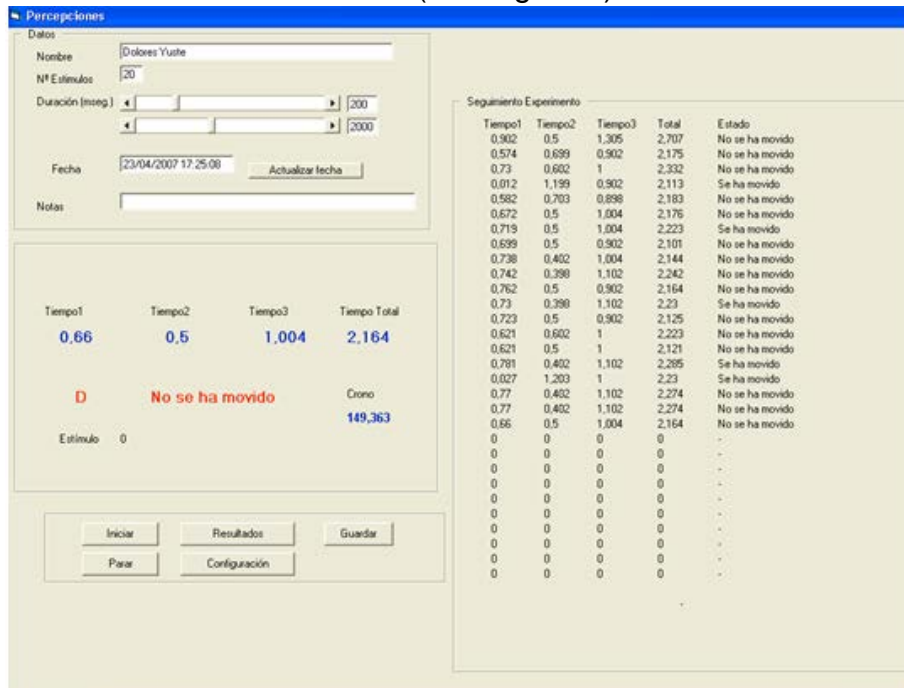


Figure 2. Result sheet generated by the recording system

The participants were normally informed about how the tools worked and the measures of the reaction time were made. Then, they developed 5 trial-tests with only 6 stimuli to stabilize their behaviour (i.e., there are no mistakes due to misunderstandings) and then develop the experimental recording test.

The subjects did physical activity on a regular basis during two months, three days per week, with a programme aimed to improve the sensory-motor stimulation. The participants of the control group continued with their daily activities.

The intervention programme included model tasks such as the following:

- The subject stops at the sign (modify the sign or stimulus: visual (poster or arm up), audio or sound (whistle, slap, etc.)) and starts moving again as quickly as possible at a new sign (modify the stop and start signs).
- At the sign, the subject takes 3 or 4 steps as quickly as possible, then keeps on moving at a normal pace.
- The subject is motionless, then lets himself/herself fall lightly forward without moving the feet and recovers balance (same task, with eyes closed).
- The subject is motionless and starts moving (2 steps) towards a given sign, not to other signs (towards the voice, but not towards the signal).
- The subject is seated and stands up at the sign (same task, with eyes closed and sound signs).
- Games that involve doing things at signs (modify the kind of sign, visual to sound and sound to visual) (example: Musical Chairs).

Once this stage was finished, the subjects from each group of the study performed again the same task analysing the simple motor reaction time to light stimuli. After the post-test, we developed the transfer test to analyse the choice reaction time: several light (20) and sound (6) stimuli were randomly applied and the subjects must response only to the sound ones; this allowed to check the strengthening level arising from the participation in the program. We registered only the response time to sound stimuli (see Figure 3).

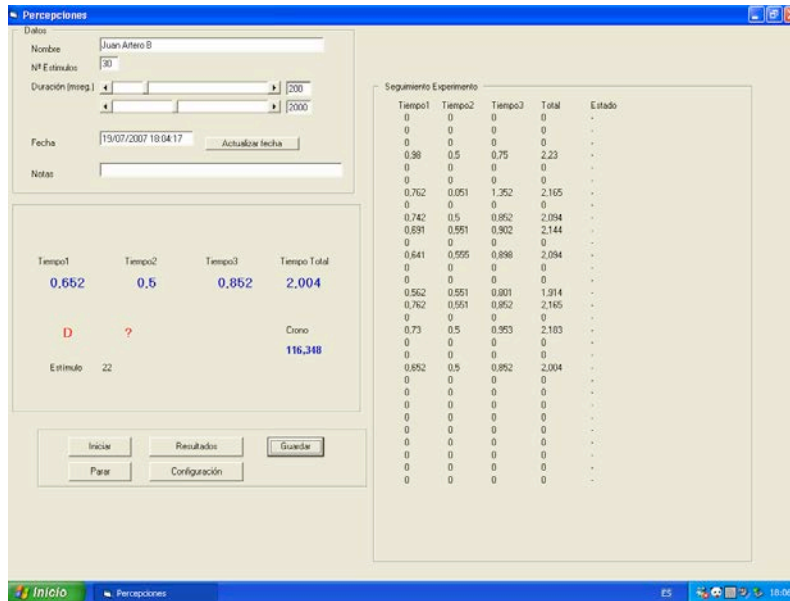


Figure 3. Result sheet generated by the recording system during the transfer test (responses to sound stimuli only)

RESULTS AND DISCUSSION

This study aimed to check the distinguishing effects of a physical activity programme (with contents that stimulate behavioural aspects aimed to improve processes such as sensation-perception, reaction response and motor response processes) on the simple reaction time, the initial movement time and the choice reaction time; determine possible differences of influence within the programme according to gender; and assess the effects of the programme on the eldest subgroup that takes part in the study.

The results do not show significant differences in the values between the groups of study, either during the post-test or the transfer test. However, the participants from the experimental group (subject to a programme aimed to improve the sensory-motor stimulation) achieve better reaction times for the two variables of the study during the post-test (**EG** sRT $M=.55$ $SD=.35$; iMT $M=.53$ $SD=.38$; **CG** sRT $M=.60$ $SD=.47$; iMT $M=.64$ $SD=.56$) (see Figure 4). On the other hand, the participants of the programme reported an improvement of their response and movement times at the end of the study compared to the beginning.

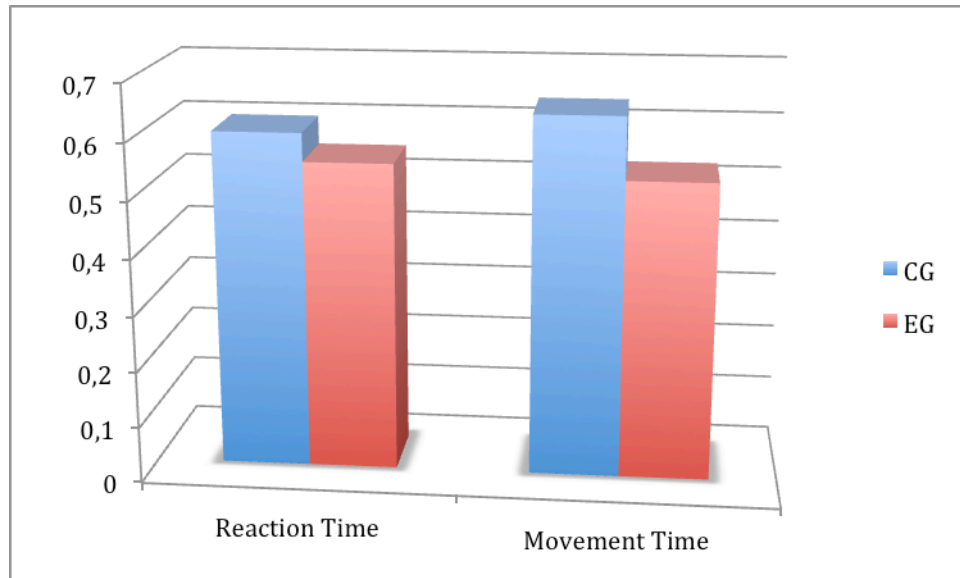


Figure 4. Reaction time and initial movement time values achieved by participants from both groups of study

A comparison of data between men and women shows that the women from the experimental group achieve the best performance for the “simple reaction time” variable, while men in the experimental group get the best performance for the “initial movement time” variable (see Figure 5).

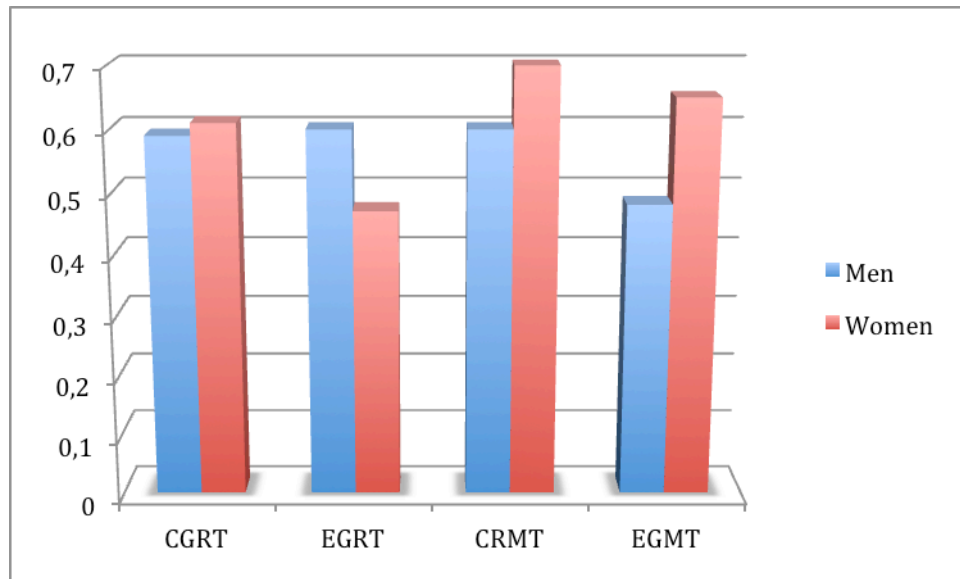


Figure 5. Reaction time and initial movement time values achieved by participants from both groups of study according to gender

A comparison of data between age brackets shows that, when analysing the reaction time values achieved by the subjects aged 70-80 years from both groups of study, the results of these participants in the control group (nonparticipation in the programme) are considerably higher than the values of all the subjects from

their group as a whole. This seems to confirm that the decline process can be more significant within this age bracket for the biomarker considered in the study (Figure 6).

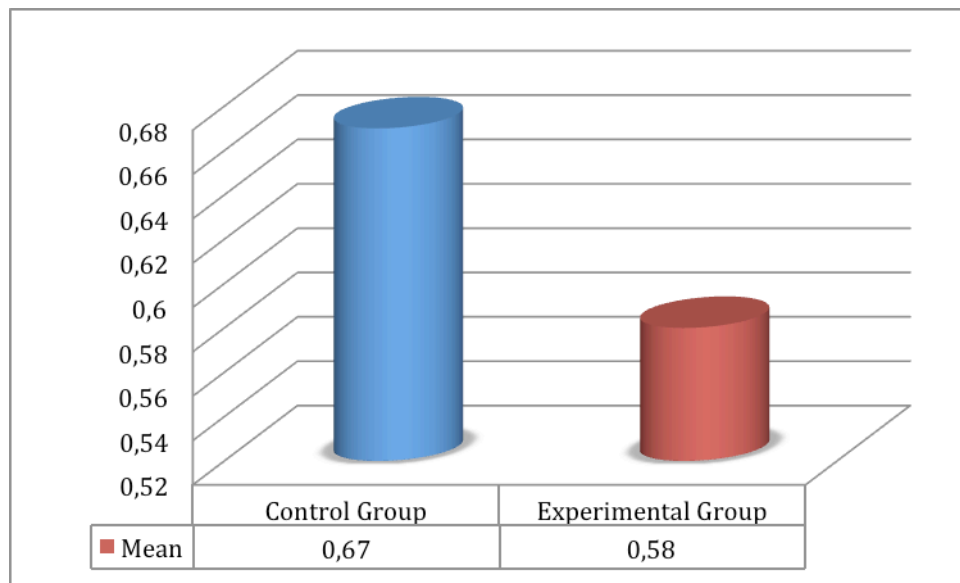


Figure 6. Reaction time and initial movement time values achieved by participants from both groups of study aged 70-80 years

Regarding the transfer test (responses to sound stimuli only), the data show a better performance of the subjects in the experimental group for the 2 components –reaction time and movement time– analysed in this test (choice reaction time) (see Figure 7).

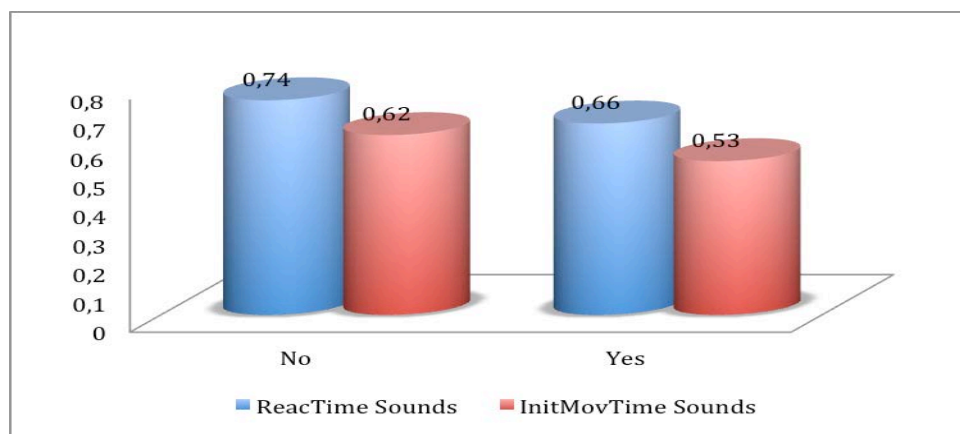


Figure 7. Reaction time and initial movement time values achieved by participants from both groups of study during the transfer test

According to the figure, the time achieved by the subjects from the experimental group is significantly better than the time of the subjects in the control group. This seems to support that participating in a physical activity programme can slow down/reduce the gradual loss in reaction time resulting from the age variable, and

avoid with it the decline of this construct showed by people over 50/60 years old, such as Jensen (1985) points out. The data also confirm that the differences are more relevant when considering only the women from both groups of study (Figure 8).

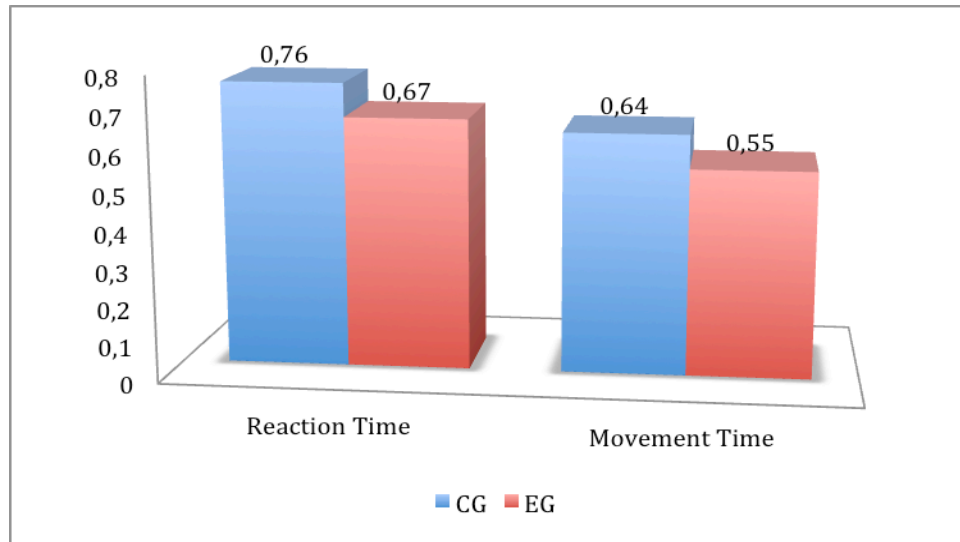


Figure 8. Reaction time and initial movement time values achieved by women from both groups of study during the transfer test

We developed a multivariate data analysis to find significant differences of performance in each subgroup (participation or nonparticipation in the programme for improvement of cognitive and gender aspects), which detected meaningful variations in the intersection “intervention programme x gender” for both the sRT and the iMT variables. Therefore, the findings seem to confirm that the programme is most efficient with women under 70 years old, who reached the best performances (RT $F= 12.345$ $p < .001$; MT $F= 7.567$ $p < .01$). These data match the results obtained by León et al. (2011) in a study with elderly people from the Spanish province of Granada.

However, we need to be careful with these findings: given the diverse nature of the activities previously performed by the most active women in the study, it is not possible to determine which elements or specific factors of each activity could have an undefined influence on the results. Thus, a review of related literature seems to confirm, for example, the widespread opinion that the aerobic exercise improves the cognitive functions (Aley et al., 2007; Barella, Etnier & Chang, 2010; Kamijo et al., 2009).

CONCLUSIONS

The results obtained after applying a physical activity programme designed with contents that stimulate behavioural sensory-motor aspects –even if they do not have a significant statistical value– match the findings by Hunter, et al. (2001), Ball

et al. (2002) and Christensen et al. (2003), which support the idea that participating in a specifically designed physical activity programme can reduce the reaction time of elderly people.

The data collected during the transfer test confirm that the participation in this programme allows to respond more efficiently to novel situations requiring this biomarker. These results are especially significant among the women from the experimental group, who show better reaction time than the other subgroups. These findings confirm the need to avoid unspecific or general physical activity programmes for elderly people, since the participants in the programme of the study showed an improvement of both the simple reaction time and the initial movement time variables in almost every component analysed, despite the short duration of the programme (2 months) and the brief time of practice (10-15 minutes per session, 3 times per week). In conclusion, the control and learning –or relearning– of movements by elderly people must be structured and planned as any other kind of training, with operative processes to measure and monitor the developments, while focusing the contents on the stimulation of cognitive processes, since this way the sRT could be improved to a greater extent. According to Gutmann & Hanzlikova (1972), it has been proved that the age-related functional decline can be delayed in people doing regular exercise. The physical activity helps to achieve a “successful aging”, that is, an aging process in which the functional skills are kept and used more efficiently than in inactive environments.

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