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POSSITIVE EFFECTS OF CONTINUOUS PRACTICE OF KARATE IN COGNITIVE CAPACITY ASSOCIATED TO THE AGE

EFFECTOS POSITIVOS DEL ENTRENAMIENTO DE KARATE EN LAS CAPACIDADES COGNITIVAS ASOCIADAS A LA EDAD

Pinillos Ribalda, M.

Interim Lecturer at the University. Department of Developmental and Educational Psychology. Faculty of Education. Complutense University of Madrid, mpinillo@ucm.es

Spanish-English translator: Ana Casimiro Ramón, anacasimiro.trad@gmail.com

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ABSTRACT

Aging is associated to a decrease of people's cognitive abilities, and, in many cases, it also comes together with a decrease of the quality of life. The main aim of this study is to identify the effects that adapted and continuous karate training may have in the cognitive abilities of people over 40 years old. Therefore, an incidental sample of 275 people was taken. A descriptive and correlational empirical work was carried out. The analyzed variable was the anticipation speed, which was estimated through the result obtained in the Kelvin Test (KCC). Age, gender and continuous Karate training were the controlled variables.

Continuous and adapted karate training had positive effects in anticipation speed amongst people over 40 years old, which implies an improvement in attention and other cognitive abilities. Regarding people who not train Karate, there are significant differences between people under and over 40 years old.

Therefore, Karate adapted training may be an interesting option to maintain the cognitive abilities during the aging processes.

KEYWORDS: karate, continuous training, aging, cognitive abilities.

RESUMEN

El envejecimiento está asociado con la disminución de las capacidades cognitivas de las personas y, en muchos casos, va acompañado de un descenso de la calidad de vida. El objetivo de este trabajo de investigación consiste en identificar los efectos que un entrenamiento adaptado y continuado en karate puede tener en las capacidades cognitivas de personas de más de cuarenta años.

Para ello se obtuvo una muestra incidental de 275 sujetos. Se llevó a cabo un trabajo empírico descriptivo y correlacional. La variable investigada es la velocidad de anticipación, medida mediante la puntuación obtenida en el test Kelvin (KCC). Las variables controladas son la edad, sexo y la práctica continuada de karate.

El entrenamiento regular en karate ha tenido efectos positivos en la velocidad de anticipación de las personas mayores de cuarenta años, lo que implica una mejora en la atención y otras capacidades cognitivas de estas personas. En los sujetos no practicantes de Karate, al llevar a cabo la comparación de medias entre mayores y menores de 40 años, sí se han encontrado diferencias significativas. Por tanto, el entrenamiento adaptado de karate puede ser una opción interesante para mantener las capacidades cognitivas a lo largo de los procesos envejecimiento.

PALABRAS CLAVE: karate, práctica continua, envejecimiento, capacidades cognitivas.

1. INTRODUCTION

Within the context of aging and preservation of the quality of life, physical training is recommended as an essential aspect to keep elderly people healthy. Its beneficial effect has been widely demonstrated in the literature and evidenced by elderly people (Gillespie, Gillespie, Robertson, Lamb, Cumming & Rowe, 2003; Baker, Fraser-Thomas, Dionigi & Horton, 2010; Nyman, & Victor, 2012; Remón, Pérez, Mateos & Lozano, 2012).

Falling down is one of the main problems that elderly people have to face (Chateau-Degat, Papouin, Saint-Val & Lopez, 2010). The gradual deterioration of cognitive abilities is one of the factors which may influence the risk of falling down (Lord, Clark & Webster, 1991). Several related studies show that physical training helps to improve psychological parameters associated to this matter (Chateau-Degat et al 2010).

Martial arts were suggested as the sport which contributes to have a healthy life and to improve its quality (Alonso, González & Cano, 2008). Slowly martial arts such as Tai Chi may be considered healthy activities for people with cardiovascular risk, although more evidences are needed to support such a claim (Taylor-Piliae, Haskell, Stotts & Froelicher, 2006). However, other martial arts with a higher speed, such as Karate, may also help to keep the physical condition of people who practice them and also they contribute to develop other cognitive abilities (Mori, Ohtani & Imanaka, 2002).

Karate is a traditional martial art where attention, strength, breathing, balance, position and movement are coordinated in order to defeat the opponent. It is a psychophysical activity which makes cognitive abilities and movement effectively combine in order to achieve the karateka's aim.

Some studies show that, in order to obtain better results, Karate training must start before the old age to promote activity in the long term in order to slow down the loss of cognitive abilities associated to the ability to anticipate and the reaction time, both related to the risk of falling down (Groen, Smulders, de Kam, Duysens & Weerdesteyn, 2010).

However, few studies of this field have researched the relationship between training karate and maintaining cognitive abilities amongst elderly people. Some studies mention the need to analyze the relationship between karate training and maintenance of attention abilities, anticipation speed and reaction time (Chateau-Degat et al 2010).

According to the results of previous studies, this study has the aim of analyzing whether prolonged karate training allows middle-aged people to delay the loss of anticipation speed compared to people who do not practice this martial art. In section 2 the background of this study are displayed; in section 3 the method and the investigation procedure used is described; in section 4, the results obtained are shown and in section 5 the implications of such results are analyzed.

2. BACKGROUND

Aging causes a series of functional changes, for instance, in sensory and motor functions. Amongst the neuropsychological changes caused by mental aging we can find a slowdown in the processing of information. These deficits indicate deteriorations due to age, in particular in those functions which require a coordinated activity (Herman, Mirelman, Giladi, Schweiger & Hausdorff, 2010; Ambrose, Paul & Hausdorff, 2013).

Several authors used anticipation speed to assess cognitive abilities in elderly people (Romero Medina, García Sevilla, Martínez Sánchez, Morales & Sánchez Meca, 1990; Ferrero, Hervás, Civera & Tortosa, 2011; Pinillos Ribalda & González Calleja, 2011). Anticipation speed can be defined as the velocity used to calculate in advance the response that should be given in a situation of uncertainty. In the strict sense, what is required in the task that is included under this heading is that the subjects accurately consider the occurrence of a fact, i.e. that they anticipate their response with such precision that it would intercept a mobile stimulus in a certain reference point (González Calleja, González Blanco, Vence Baliñas, González Calleja, Morales Díaz & González Uriel, 2001).

In anticipation speed the following elements can be found:

- Identification of stimuli that may be susceptible of a reaction. This ability to perceive events in a fast and detailed way in complex situations of spots is an essential requisite for an effective performance of different sports (Williams & Elliott, 1999). According to Granda Vera et al. (2006), this ability is related to the quality of the visual system or with the expert knowledge.
- Decision on whether the stimulus is due to a situation which requires to adopt a response as well as the most suitable response in accordance with the received perception (Mori & Shimada, 2013).

Studies about anticipation speed show small differences between young and elderly people regarding simple tasks, but wider differences when the tasks are more complex. These differences seem to be more obvious with regards to tasks where movements cannot be predicted and prepared in advanced, especially if it is needed to perform complex and coordinated responses (Chateau-Degat et al., 2012). This is possibly due to the fact that they spend more time to interpret the signals before giving a response and also to consider what they are doing (Jansen & Dahmen-Zimmer, 2012). In these tasks of simulation, the compensatory effect that can be given by the experience is cancelled due to the novelty of the tests (Romero et al., 1990).

Advanced age generally affects negatively to speed –and not only to anticipation speed-, as a particular effect of aging. According to Weineck (1988), speed is the element of the performance which experiments, with the age, the quickest and earliest regression.

Weineck includes in his study a graphic design of a variable closely related to anticipation speed, which is the reaction time, in which it is clearly shown how the reaction time varies according to age, decreasing clear and constantly from the age of 40. Weineck also claims that latency and reaction times achieve identical values to adults in the last period of puberty, i.e. from the age of 15. In addition, it is also shown that karate training makes speed does not decrease with age (Layton, 1993). Although his study was related to karate trainee's reaction time, he could observe that it had no relationship with age, even though it is a more physiological than cognitive variable.

Mori & Shimada's study (2013) indicated that expert karatekas have greater effectiveness regarding anticipation speed than beginners. Besides, the conclusion of this study is that karatekas' anticipation abilities are not due to the process of taking decisions, but they depend on two factors (where the first is more influential than the second): a) extraction of information from the early movement of the opponent; b) determination of the received action's objective. Martínez de Quel (2008) claims that both in all combat sports in general and in karate in particular it is considered that a suitable reaction time would help the subject both in the sport and in daily life.

In this context of great interest, this study has the aim to analyze whether prolonged karate training allows middle-aged people to slow down the loss of anticipation speed compared to people who do not train this martial art. In addition, it is important to identify the karate training patterns that reinforce anticipation speed and that contributes to slow down the decrease of cognitive abilities related to age when increasing complexity. Some of these activities will be described in the discussion about this study's implications.

3. MATERIAL AND METHODS

3.1 Hypothesis

This study aims to test the following hypothesis:

“Prolonged karate training amongst people over 40 years old contributes to slow down the loss of cognitive abilities related to anticipation speed”.

3.2 Subjects

The sample of karate practitioners was selected from several sports centers located in Madrid; the sample of non karate practitioners was formed by people who do not practice karate but with similar ages and gender to the first group.

The aim was to obtain a sample of karate practitioners and non practitioners with the same number of people. In addition, the inclusion criteria aim to obtain a similar range of ages between practitioners and non practitioners. Besides, with the objective of being able to take into account other variables such as laterality or gender, the sample is thought to consider a distribution of left-handed and right-handed with a similar proportion to the Spanish population

(10%-90%) and with an enough representation of both men and women. There have also been included people of different karate level in order to analyze the results according to the variety of experience.

For obvious reasons, it is not always viable to obtain information of all member of a population, even if we try to reduce it only to karate practitioners or non practitioners from Madrid, not only due to the big size of the population, but also to aspects related to the characteristics of this study such as the specific distribution of each sports center with different timetables to train this martial art, very small groups in some cases, etc., which force the need to establish inferences about the values of the population from a sample as the one selected for this study. Therefore, the incidental sampling procedure, despite the disadvantages it carries, has been the selected for this study.

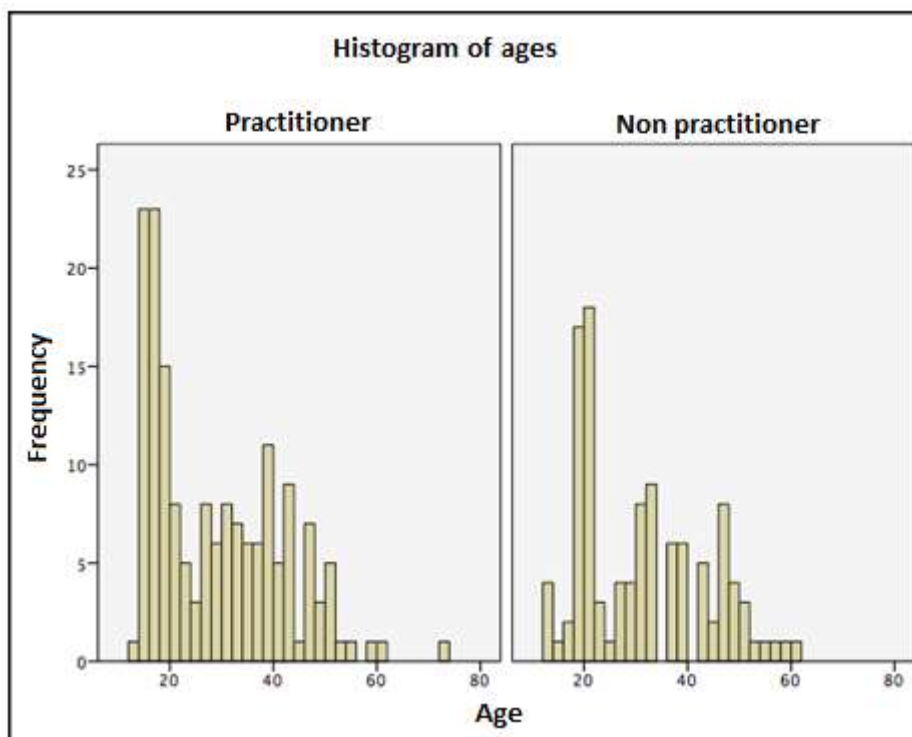
The sample consists of 275 subjects. A detailed description of this sample is given below.

Age

The average age of the sample (N=275) is 29.69 years old (SD = 12.71), with a range from 13 to 73 years old. The average age of the non practitioners of karate is 30.74 years old and of the karate practitioners is 28.64 years old.

Detailed information about the distribution of the sample according to age is shown in figure 1.

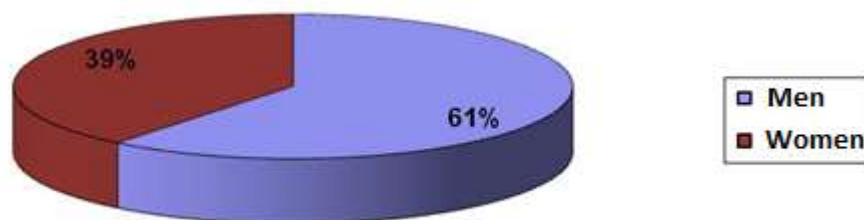
Figure 1. Histogram of the sample according to participants' age



Gender

As it is shown in figure 2, in total, 39.3% of the subjects were female and 60.7% were male.

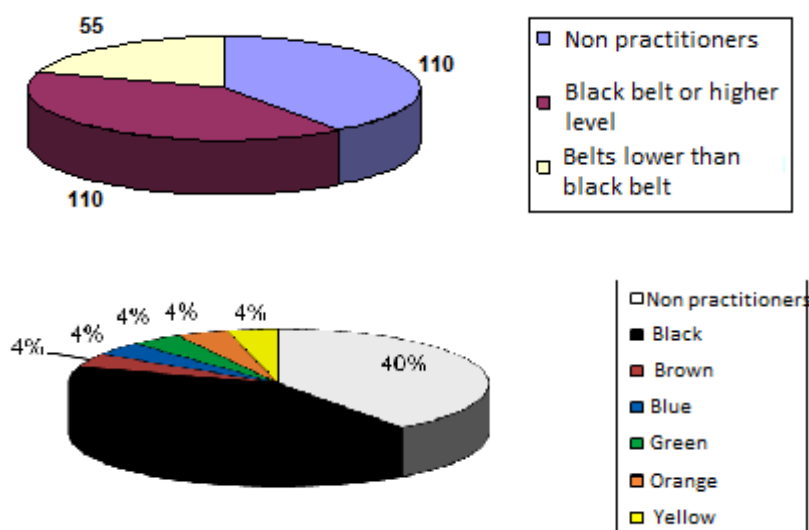
Figure 2. Description of the sample by gender



Karate practitioners

Figure 3 provides detailed information regarding the distribution of karate practitioners and non practitioners, and the distribution of the formers according to their level of experience in this martial art.

Figure 3. Distribution according to the experience in Karate



Laterality

Figure 4 provides detailed information of the distribution of participants according to their laterality conditions.

Figure 4: Distribution according to laterality



3.3 Variables

a) Analysed Variables

The analyzed variable is the anticipation speed. The concept of anticipation speed allows the analysis of several cognitive aspects such as the processes of analysis, selection, codification and recovery of the available visual information, as well as the fast determination of the action to develop as a consequence of a stimulus received (Mori & Shimada, 2013).

In order to measure the anticipation speed the KCC Test is used (González Calleja & Cerro Rodríguez, 1986; González Uriel, 2001). This test is used because it requires small time to develop and it has an acceptable reliability (0.81). This test is perfectly suitable for this study's aim, since the ability to anticipate speeds and variable paths is directly correlated to the ability to anticipate uniform and unidirectional movements which take places at different speeds.

On the screen, a light spot representing the moving object moves in different directions with uniform motion at the speed selected by the person running the experiment. At a given time it is visually hidden, completing its tour or stopping, according to the will of the subject. The aim of the visible part of the tour is to show the speed of the object when it moves (light spot) so that the subject is able to stop it in the exact moment it should meet a fixed reference (another light spot), set within the tour.

The moving object (red light) moves at a constant speed and following a straight direction. Another red light of the same characteristics is used as the fixed reference which indicates the starting point of the non visible part of the tour, while the reference point I represented by a green light. There are four speed options to move the red light.

b) Controlled Variables

The controlled variables are the following: a) gender (1- Male; 2- Female); b) Age (of the participants); c) Laterality (1- Right-handed; 2- Left-handed); d) Karate training (if the subject practice or not karate regularly); e) Karate belt (Black, Blue, Brown, Green, Orange or Yellow).

3.4 Tools

a) *Anticipation Speed Test. Kelvin System (KCC)*

The objective of this test is to measure the ability to consider space for a moving object at different speeds and its adaption to each of them (González Calleja & Cerro Rodríguez, 1986).

b) *SPSS Program to analyze data*

3.5 Procedure

First of all, we selected several sport centers from Madrid in which we could have access to subjects with different belt levels, we presented the aim of the study and the kind of collaboration required from karate practitioners.

During the performance of the study we regularly attended to the training sessions developed in each of the selected sport centers with the aim of studying in depth the exercises performed and their relationship with anticipation speed.

With the aim of ensuring that the control group (non practitioners of karate) performed the test under the same conditions, the decision was to perform these tests at similar times and environments.

The range of time used to perform the test was always in the evening. After explaining the reason of the study and asking enough collaboration and motivation, the test was performed to all subjects.

Subjects performed as a preparation a trial phase at the second speed (12.5m/s) with the aim of knowing the functioning of the appliance and to familiarize themselves with the button. The instructions were provided in accordance to the manual of the Kelvin Test.

All applications if the test were conducted by selecting manual mode in the control panel. Once the trial had been performed, the subjects were reminded that from that moment they would not see the moving object from the fixed indicator.

After checking that there were no doubts the actual test started hiding the moving object in all tests and without feedback regarding their results.

The test was developed in two phases (Phase A and Phase B), maintaining the order of the series. It started with the slowest speed of the series ($S1=9.72$ m/s), followed by the intermediate speed ($S3=19.44$ m/s) and the fastest speed ($V4=38.88$ m/s), in this order.

All data were registered at the moment in a form that included the obtained results by each subject in each of the phases (A and B), at each speed (S1, S3 and S4), and the overall result.

Once we obtained the results we analyzed them. We calculated the averages obtained by subjects in total scores of anticipation speed. The measurements in the test are shown in hundredths of a second and transformed into space-error units.

In order to interpret the results we take into account the fact that the score of a subject whose responses were not anticipated nor delayed to the presented visual stimulus would be zero. Therefore, the most precise are the responses of a subject to the presented stimulus the closest to zero must be his/her final score in the Kelvin Test.

4. RESULTS

We studied the distribution of the construct anticipation speed in our population. Kolmogorov-Smirnov Test is used in order to determine if the obtained data meet a normal distribution and, in this way, are considered suitable to be studied and statistically analyzed. Obtained data meet the normal probability curve if we take napierian logarithms from the Test's scores (see Table 1). These data are coherent with those obtained in other similar studies (González Calleja & Cerro Rodríguez, 1986; González Uriel, 2001).

Table 1. Distribution of the construct anticipation speed

Kolmogorov-Smirnov Test for the sample			
		Anticipation Speed (AS)	Ln (AS)
	N	275	275
Normal Parameters	Average	31.9524	3.3258
	Standard Deviation	17.34925	0.53101
	Maximum Value	103.08	7.83
	Minimum Value	4.64	2.06
Largest differences	Absolute	0.120	0.043
	Positive	0.120	0.043
	Negative	-0.083	-0.039
	Z of Kolmogorov-Smirnov	1.995	0.720
	Asymptotic Sig. (bilateral)	0.001	0.677

We also calculated the KCC Test's reliability coefficient for the whole sample through the procedure of the two halves, taking advantage of the parallelism between test A and test B (see table 2).

Table 2. Calculation of the KCC Test's reliability coefficient in the sample

		Test A	Test B
Test A	Pearson Correlation	1	0.614
	Sig. (bilateral)		0.000
	N	275	275
Test B	Pearson Correlation	0.614	1
	Sig. (bilateral)	0.000	
	N	275	275

The Pearson correlation coefficient is calculated to determine the reliability of the obtained data. In table 2 is shown that the result obtained was 0.614. However, this result indicates the reliability coefficient of a test with half of the sample of this study; therefore, in order to determine the actual reliability of the test, the Spearman-Brown prediction formula was performed. In our case, the formula would be reduced to $2r/(1+r)$, i.e. $2*0.614/(1+0.614) = 0.76$. This reliability coefficient of 0.76 is coherent with the published in other studies previously mentioned (González Calleja & Cerro Rodríguez, 1986; González Uriel, 2001).

Therefore, it is shown that both the distribution of the studied variable, anticipation speed, and the reliability of the test used to measure it in our sample fulfill the conditions established to consider them suitable in the field of an empirical research and along the line of other studies such as those of González Calleja and Cerro Rodríguez (1986) and González Uriel (2001).

In order to determine the possible reduction of the effects of aging through karate training, comparisons of means between karate practitioners and non practitioners were performed using Student T Test, dividing both groups in two age categories: under 40 years old and over or equal 40 years old. Data related to these calculations are graphically summed in the box-plots in figures 5 and 6. These data can be consulted in detail in Pinillos (2010).

Regarding karate practitioners, when comparing means between older and younger than 40 years old, there were no statistically significant differences with regard to age and anticipation speed ($t = 1.24$; $p = 0.21$), since only p values under or equal 0.05 are considered significant. Amongst non karate practitioners, when comparing means between older and younger than 40 years old practitioners, there are statistically significant differences regarding age and anticipation speed ($t = -2.15$; $p < 0.05$). The mean of the group under 40 years old is lower (and therefore more precise) than the group over 40 years old.

Figure 5. Means comparison. Participants under 40 years old

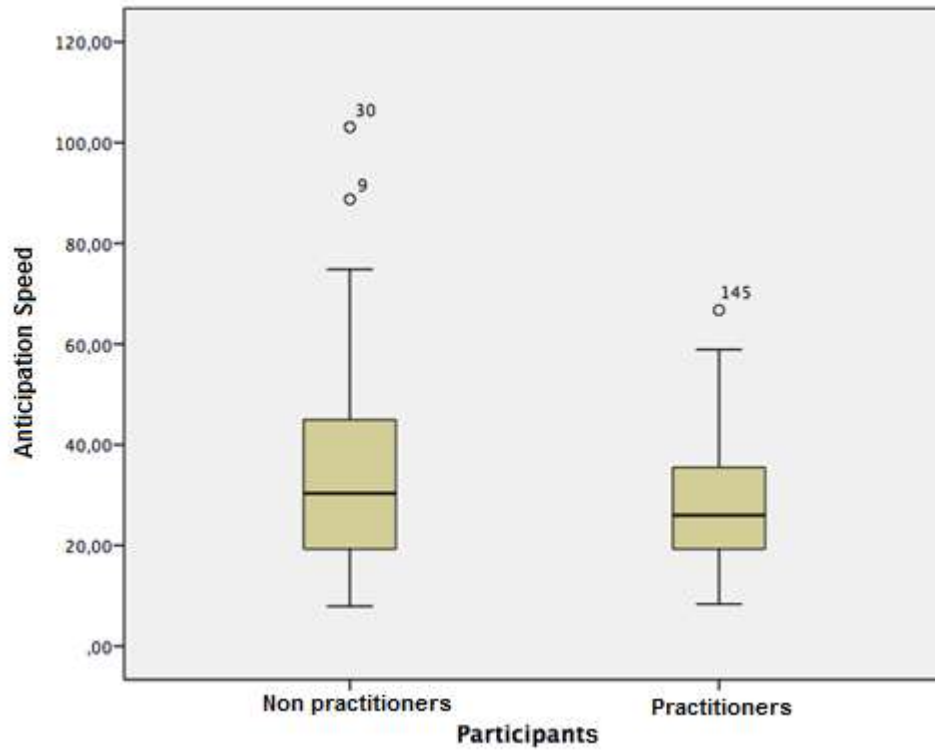
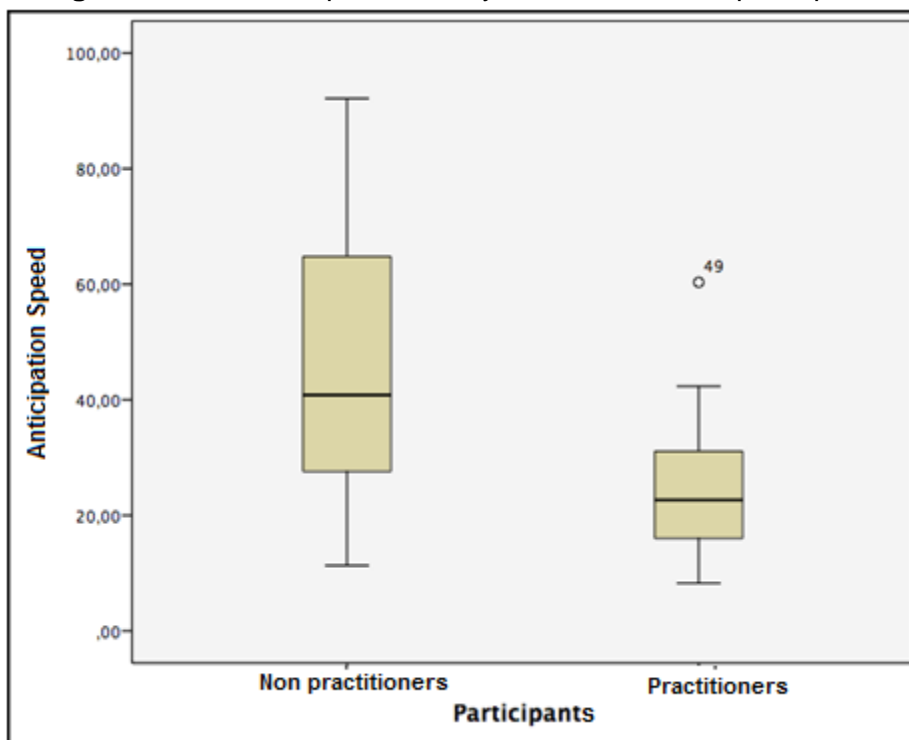


Figure 6. Means comparison. 40-year-old or over 40 participants



In order to delve into the study of the influence of the experience in the practice of karate, there have been performed multiple comparisons regarding anticipation speed among the different groups analyzed, as it is shown in table 3.

Table 3. Comparison of means for all analyzed groups

(A) Groups	(B) Groups	Mean difference (A-B)	Standard error	Sig.	Confidence interval at 95%	
					Upper limit	Lower limit
Non practitioners	Black belts or higher	9.298485(*)	2.282169	.000	3.79741	14.79956
	Belts lower than black belt	6.724242	2.987105	.076	-.50134	13.94983
Black belts or higher	Non practitioners	-9.298485(*)	2.282169	.000	-14.79956	-3.79741
	Belts lower than black belt	-2.574242	2.537891	.676	-8.75741	3.60893
Belts lower than black belt	Non practitioners	-6.724242	2.987105	.076	-13.94983	.50134
	Black belts or higher	2.574242	2.537891	.676	-3.60893	8.75741

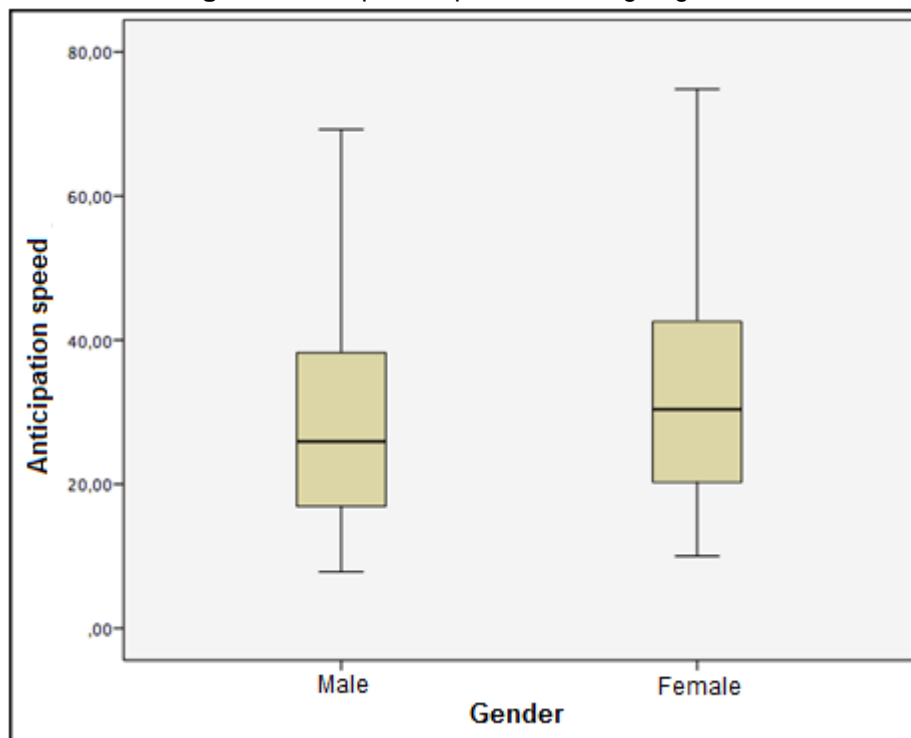
In table 3, the means difference shows the highest and lowest anticipation speed between the different groups (non practitioners, practitioners with belts lower than black belt, and with black belt). In this table, the column of significance (Sig.) determines whether the means difference is relevant in order to show that there is a clear difference in anticipation speed amongst people belonging to both groups. The means difference is considered significant when the result is 0.05 or lower.

We can see significant differences in the variable anticipation speed amongst subjects who do not practice karate and black belt karate practitioners. Black belts, with a mean of 27.71 m/s are significantly more precise than non karate practitioners, whose mean is 37.01 m/s.

Between non karate practitioners and intermediate level belts there are differences regarding anticipation speed, since intermediate belts are more precise (mean: 30.29 m/s) than non karate practitioners (mean: 37.01 m/s). These differences are not statistically significant but as their significance value ($p = 0.076$) is very close to the verge ($p \leq 0.05$) a clear trend relationship is shown in the anticipation speed between the two groups.

The comparison between black belts and intermediate color belts also shows differences, even if they are not statistically significant, in the variable anticipation speed, where black belts are more precise than the others, which may show that those psychomotor benefits related to karate appear relatively swiftly.

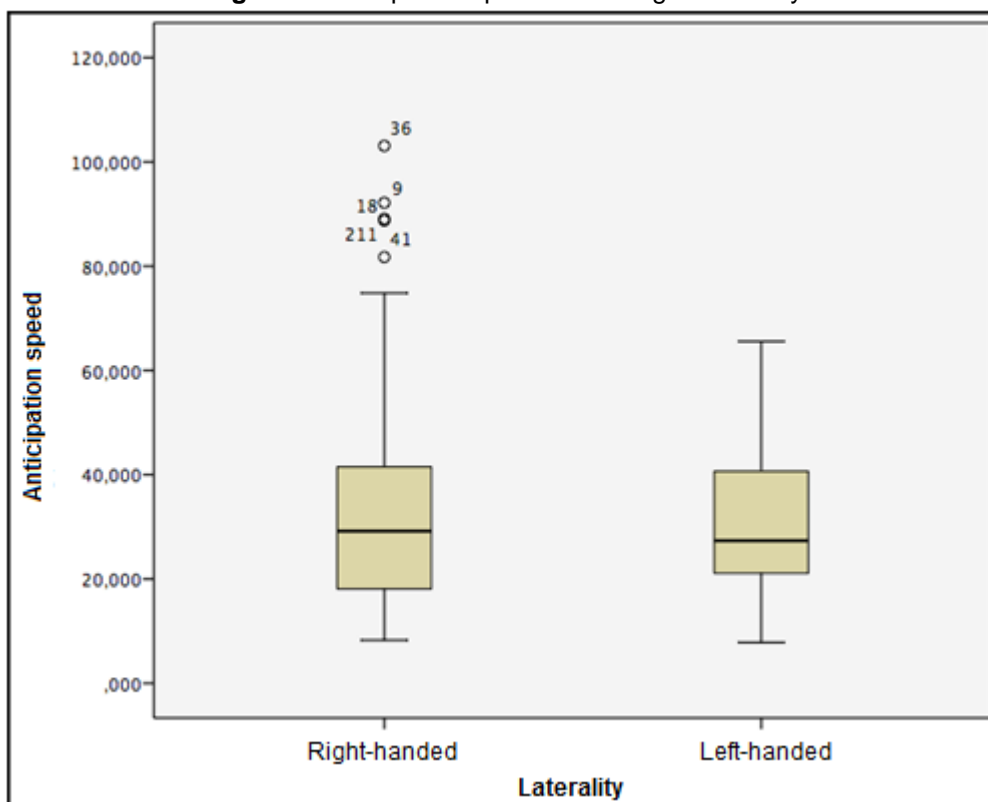
Figure 7. Anticipation speed according to gender



In order to know that gender has no influence on anticipation speed the means difference statistic Student T test was used. Data related to these calculations are graphically shown in figure 7 and can be consulted in depth at Pinillos (2010). According to the obtained data, there are no statistically significant differences in anticipation speed between men and women ($t = -1.62$; $p = 0.10$), so it can be said that gender has no influence on anticipation speed.

With regards to the analysis of participants' laterality the means difference statistic Student T test was used. Data related to these calculations are graphically shown in figure 8 and can be consulted in depth at Pinillos (2010). In the field of this study ambidextrous people were not included due to the small amount of them within the sample.

Figure 8. Anticipation speed according to laterality



In conclusion, there were not found statistically significant differences in anticipation speed between right-handed and left-handed people ($t = -1,34$; $p = 0,89$), so we can conclude that laterality does not affect anticipation speed.

Therefore, continuous karate training would improve the level of anticipation speed amongst people older than 40 years old even despite other variables such as gender or laterality.

5.- DISCUSSION

The results above presented confirm that there are significant differences regarding anticipation speed between black belts and non practitioners, since black belts are significantly more precise than non practitioners.

This is strictly consistent with the analysis of karate from a psychomotor point of view. Neurocerebral and muscular times -indispensable components with regards to anticipation ability (Mori et al., 2002)-, may be reduced with karate common training tasks. A great part of karate is based on automating reactions, especially with defense/attack linkages anticipating themselves to any new offensive reaction from the opponent, since we must not forget that the key principle of karate is that defense is equal to attack.

In addition, in karate, as a discipline, practitioners specifically work on how to know when someone is about to attack them through observing concomitant details, and in this sport the ability to react is constantly trained, so that this practice could improve subjects' precision in the variable anticipation speed

(Mori & Shimada, 2013). These aspects are relevant to maintain cognitive abilities related to falling down prevention, since they work on elements such as intuitive elements which are narrowly linked to it. In fact, in karate training physical and physiological principles directly linked to the improvement of anticipation speed are used: precision, propitious moment, hitting time, performing speed, amongst others.

Therefore, according to the results obtained in this study, continuous karate training contributes to slow down the loss of quality of life. In particular, it can be a useful element to prevent the deterioration of cognitive abilities related to the risk of falling down. In the study of aging, several physical exercises are recommended in order to slow down and prevent the process of aging and its effects (Hong, Li & Robinson, 2000; Li, Hong & Chan, 2001 y Taggart, 2002). Similar results were obtained in related studies of martial arts, for instance, Tai Chi is related to well-being amongst traditional Chinese practitioners (Hong & Robinson, 2000; Taylor-Piliae et al 2006).

Continuous training improves levels of performance even despite other variables which may influence against this improved performance such as age. In this study it is surprising how precision in the Kelvin test improves from the age of 40 in the case of black belts. This is probably due to the fact that continuous training of sports which foment variables related to anticipation speed makes this variable remain the same level or improve despite the side effects that aging may cause.

Advanced age, in general, affects negatively to speed as a characteristic effect of aging. Speed is the performing factor which, with age, experiments a quicker and earlier regression (Weinech, 1988). According to such study, it is also relevant the fact that the decline in the resistance ability of the organism in the last years of life is rather a translation of the genre of work and the way of life in the modern industrial world than a biological rule. The so-called aging processes frequently conceal a state of inadequate training, so it is not surprising the fact that continuous sport training and especially anticipation abilities in activities such as karate manage not only to keep them but even to increase them in ages exceeding 40 years old (Jansen & Dahmen-Zimmer, 2012).

The results of this study are also consistent with Layton (1993). In these studies it was observed that karate training helps speed not to decrease with age, as it happens with groups of people not characterized by the practice of this activity. Although that study was related to reaction time of karate practitioners, it showed that it had no relationship with age.

The results obtained also suggest the need of future studies exclusively focused on elderly people who practiced karate regularly during several years. According to Chateau-Degat et al. (2010), the need to prevent falls and their consequences is more and more important.

However, this study has some constraints inherent to the design of studies of this kind. The size and nature of the sample (for instance, the distribution of participants' age is similar but not exactly the same) slightly limit the external validity for the generalization of the results. Besides, it would also be recommended to continue studying participants over a longer period of time (at least during 18-24 months) to analyze more precisely the tendency in the evolution of cognitive abilities amongst people who practice karate and people who do not.

In addition, it is also relevant to study the influence that possible educational and social contexts have on the continuous practice of karate in advanced ages and its relationship with cognitive abilities related to aging processes.

In addition, it can be said that the measurement tool, the KCC system, is valid for this study's purposes. This method can be improved in its configuration and the instrumental presentation, but its reliability reported in previous studies (0.81) is high and the estimated reliability in this study (0.76) may be considered acceptable. However, certain improvements that can be considered are the use of integrated cameras into mobile devices, sensors of movement and some other more powerful mobile machines in order to monitor the progress of cognitive abilities and abilities related to anticipation in sports with the aim of analyzing with a greater precision the cognitive elements related to anticipation abilities.

It should be noted that although in other studies (Uriel & Jiménez, 2000 amongst others) it is concluded that videogames favor anticipation speed, but this variable was not considered in this study because it focuses on the analysis of prolonged karate training which helps, amongst people of 40 or over years old, to slow down the loss of cognitive abilities linked to anticipation speed. In this case, the population over 40 years old do not regularly use videogames; therefore, it is not expected an important influence in the study of this variable in this population's group. However, since the evolution of the population habits will make the use of videogames more frequent, it is expected that in the medium-term future this variable may influence in the results of anticipation speed in older people.

The results obtained are considered statistically valid as they are presented in section 4 of the article; however, the validity of such results can be established in a wider way from the following points of view:

- Regarding the validity of the construct, it can be established that the measures used to measure the considered independent and dependent variables faithfully measure the construct anticipation speed. It is also important to claim that in order to develop a deeper study of the impact of karate training on preserving certain cognitive abilities, more modern measuring tools should be used, as it was previously established.
- A level of reasonable reliability can be set regarding the cause-effect relationship between independent and dependent variables considered in the

experiment that was carried out; however, in order to reinforce the validity of the obtained conclusions, it would be recommended that future studies consider other sports or recreational practices not related to martial arts.

- Finally, it would be recommendable to be able to continue this line analyzing more variables than the studied so far, such as those related to karate but not only as a sport but as a philosophy of life. Karate cannot be withdrawn from the cultural context where it appeared and along this line it is a way of life which allows, with the suitable training, to optimize the performance of different variables that may, in different ways, improve the quality of life and physical and psychological health of its practitioners.

6. CONCLUSIONS

In conclusion, the results of this study indicate that continuous and adapted karate training can contribute to the reduction of the inexorable process of aging. Karate training seems to facilitate the cognitive dimension related to this process. In terms of the promotion of sports and physical activity and public health, adapted karate training may be an interesting option to keep a healthy sporting activity during the process of aging.

This study shows that regular karate training implies an improvement in attention, coordination and a lot of other cognitive variables. Continuous karate training may result in a reduction of neurocerebral time by stimulus-response since this martial art is based on speed -and therefore in the reduction of muscular time in its motor part- far more than in the strength.

As it is well claimed by González Calleja et al. (2005), following Elner & Hommel (2001, p. 256), automatic stimulus-response integration and automatic preparation of the response are possibly basic processes to focus the attention in the control of the voluntary action through anticipation of the action's aims. Karate teaches to catch stimuli so subtle that are virtually negligible for an amateur and which report the imminence of the eliciting impulse, so that practitioners of this martial art can anticipate stimuli more that react against them. In addition, the automation of stimulus-response allows the minimization of any latency time.

Senso-perception variables are also improved with the continuous karate training. The speed of visual perception is a variable which is developed in any person who practice karate, since in karate, as Kim and Petrakis (1998) state, as in other sporting activities with constant changes of environment, practitioners must take decisions quickly, which requires a high perceptual speed.

Peripheral vision and perceptual and visual searching strategies are improved by karate training. Peripheral vision is trained in karate to collect information from peripheral areas such as arms and legs. Regarding the training of visual searching strategies in karate Williams and Elliot (1999) affirm that continuous

karate training may promote more efficient searching strategies focused on different areas of vision.

Continuous karate training favors perceptive anticipation. According to Granda Vera et al. (2006), it has been discussed whether the improvement of perceptive anticipation is more related to the quality of the visual system or to the expert knowledge that comes from the experience of the karate practitioner; most studies consider the second option. Other authors study this matter distinguishing between the hardware perspective or quality system, and the software perspective or knowledge structures. Hardware factors highlight physical differences in the mechanical and optometric properties of the visual system, while software factors are cognitive differences in the processes of analysis, selection, codification and recovery of the visual information available.

Reaction time and self-control are also variables which improve with karate training, since together with the perceptive anticipation, both constitute essential elements in the variable anticipation speed, variable which is exhaustively trained in karate.

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