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INFLUENCE OF MOTOR EXPERTISE IN THE MIRROR NEURON SYSTEM ACTIVATION: NON-DANCERS VS EXPERT BALLET DANCERS

By Kenia Arteaga Fuentes

Supervisor: Glòria Marsellach Umbert

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ABSTRACT

The mirror neuron system (MNS) involves a group of neurons in the brain that respond to the performance and observation of similar motor actions. Investigation of this system has furthered the understanding and representation of action comprehension and other fields of interest in cognitive neuroscience. In this study, the aim is to look at differences of response between both groups following the observation of expert ballet dancers' performance and everyday movements, and also their ability to discriminate the correctness of specific actions observed. METHODS: Ten adult female volunteers were selected to participate. They were divided in two groups: experimental (ballerinas) and control (non-dancers). EDQ, Eye Tracking Technology and SuperLab were used to extract and analyse data. RESULTS: Differences between groups were only found in terms of fixation perimeter during expert movements observation. Correlations showed direct relation between action familiarity variables and motor expertise. DISCUSSION: Results show that motor expertise is a good predictor for the ability to comprehend the actions observed and the imagination of oneself executing those specific movements. It would be interesting to further explore these findings with a bigger sample size and EEG analysis.

RESUMEN

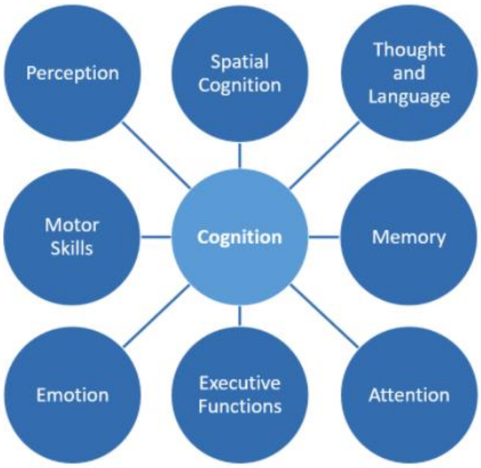
El sistema de neuronas espejo (SNE) involucra un grupo de neuronas en el cerebro que responden al desempeño y observación de acciones motoras similares. La investigación de este sistema ha fomentado la comprensión y representación de la comprensión de la acción y otros campos de interés en la neurociencia cognitiva. En este estudio, el objetivo es determinar si existen diferencias de respuesta entre ambos grupos tras la observación de la acción de bailarines de ballet expertos y de movimientos de la vida cotidiana, y también su capacidad para discriminar si las acciones específicas observadas son correctas o incorrectas. MÉTODO: Se seleccionaron diez mujeres adultas voluntarias para participar. Se dividieron en dos grupos: experimental (bailarinas) y control (no bailarinas). Se utilizaron el EDQ, la tecnología Eye Tracking y SuperLab para extraer y analizar los datos. RESULTADOS: Solo se encontraron diferencias entre los grupos en términos de perímetro de fijación durante la observación de movimientos de expertos. Las correlaciones mostraron una relación directa entre las variables de familiaridad con la acción y la experteza motora. DISCUSIÓN: Los resultados muestran que la experteza motora es un buen predictor de la capacidad de comprender las acciones observadas y la imaginación de uno mismo ejecutando esos movimientos específicos. Sería interesante explorar más a fondo estos hallazgos con un tamaño de muestra más grande y un análisis con electroencefalografía.

Key words: Motor Cognition, Mirror Neuron System, Motor Expertise, Ballet Dancers, Psychophysiology.

1. Introduction

The study of cognition has made considerable progress over the past decade. Cognition, also known as mental activity, is the internal interpretation or transformation of stored information (Redolar-Ripoll, 2014). Information is acquired through the senses and stored in memory. Specifically, there's a branch of psychology which studies mental activity, which is called **Cognitive Psychology** (Smith & Kosslyn, 2008, p. 3). Cognitive psychology involves the study of internal mental processes (perception, thinking, memory, attention, language, motor skills, problem-solving, and learning). While it is a relatively young branch of psychology, it has quickly grown to become one of the most popular fields of study. There are numerous practical applications for this cognitive research, such as finding ways to help people recover from brain injury, providing assistance coping with memory disorders, treating learning disorders, increasing decision-making accuracy and more (Logan, 2021). Learning more about cognition, about how humans think and process information helps researchers to gain a deeper understanding of how the human brain works, and also it allows psychologists to develop new ways of helping people to deal with psychological difficulties (Banich & Compton, 2018).

Fig1. Visual scheme of cognitive psychology (Gazzaniga & Heatherton, 2015).



1.1. Theoretical framework

In this work, different basic cognitive processes are going to be studied. As it is mentioned in the title, here is going to be exposed the relationship between motor expertise -motor skills- and the activation of a specific type of neurons called mirror neurons. As the reader can see, this final bachelor's degree project is framed in Cognitive Psychology and it is also focused in the paradigms used in the study of Cognitive Neuroscience. It is important to mention that much of the recent progress in the study of cognition comes from the advent of Cognitive Neuroscience, which uses neuroscientific paradigms and methods to address psychological issues (Redolar-Ripoll, 2014).

1.1.1. Historical background

The first psychology laboratories, in the 19th century, were dedicated to investigate about the nature of the mental activity. The scientific studies of mental activity began with the establishment of the first contemporary laboratory of psychology in 1879, in Leipzig (Germany); the director of this laboratory was the well-known Wilhem Wundt (1832-1920), who focused on studying the nature of consciousness (Kosslyn & Smith, 2008). Almost at the same time that Wundt's laboratory was in full operation, another orientation of scientific psychology was promoted, principally in America thanks to William James (1842-1910). American psychologists focused on the function of mental activities and their role in the environment. The functionalist approach provided a solid base for later studies; mental activity began to be studied from different approaches that have provided psychology with a vast range of knowledge. Basic or also called experimental psychology, studies the general psychological processes that are the basis of human behavior (Jeannerod, 2006).

William James was the first author to mention a subfield of study called *motor cognition*, in his manual *Principles of Psychology* published in 1890, he talks about the interdependency between perception and action. He concluded that we plan so that we can achieve an objective of action and what we perceive allows us to know if we are closer to achieve that objective or if we are on the wrong way. He illustrated this idea with the following example of reaching movements: "Keep your eye at the place aimed at, and your hand will fetch [the target]; think of your hand, and you will likely miss your aim." (James, 1890).

In the next paragraphs the variables studied for this research are going to be defined. Henceforth, the study of motor skills is going to be called Motor Cognition (MC).

1.1.2. Definitions

<u>Actions and cognition</u>

Actions are critical steps in the interaction between the self and the external environment. Actions are the reflection of psychological processes which begin far from the appearance of the muscular contractions that produce the rotation of the articulations and the movements of the limbs (Bläsing, Puttke & Schack, 2018). In this sense, they can reveal the intentions, the desires and the goals of the acting self, particularly when they are self-generated and not mere responses to external events. Investigations the way actions are planned, thought, intended, perceived, organized, learned, understood, imitated, attributed or basically, **the way they are represented**, is the program of the new and rapidly expanding field of **motor cognition** (Jeannerod, 2006). Any motor act, including even the simplest reflex responses, is the result of the simultaneous and coordinated activity of multiple cortical and subcortical centers (Redolar-Ripoll, 2014).

<u>Motor cognition and Mirror Neuron System</u>

Motor cognition covers all mental processes involved in planification, preparation and production of our own actions, as well as all mental processes related to anticipation, predictions and interpretation of the actions of others (Smith & Kosslyn, 207). In MC research**, motor priming** is the effect by which observing a movement or an action makes it easier to perform a similar motor response (Smith & Kosslyn, 2008). In this sense, the process of “making easier to make actions previously made” is due to the mental representation of the actions that are called motor programs. González-Rothi et al., (1997) developed a theory of a subsequent storage of motor programs called **praxicon** that will be cited in this work. So, definitely observing an action facilitates the ability to plan and perform these movements. Electrophysiological studies have shown the presence of a type of neuron that behaves like the actions are taking place, inhibiting movement: these are the mirror neurons (Calvo-Merino et al., 2005). This neural response is also called **empathetic response.** This set of neurons that act as if movements were taking place is called the **Mirror Neuron System (MNS)** and its function is key to the mental representation of action plans (Smith & Kosslyn, 2008). Mirror neurons were discovered in the 1990's in the premotor cortex of the rhesus macaque. These special, visuo-motor neurons discharge action potentials when executing an action, as well as during the observation of the performance of a similar action (Lago-Rodríguez et al., 2014). The discovery of mirror neurons provides neurophysiological evidence for a direct matching between action perception and action production (Heyes, 2010).

When observing others interacting with the environment, humans systematically fixate action plans and action goals ahead of time. Such predictive eye movements emerge early in human development and continue to play a crucial role for collaboration and competition throughout life (Kanakogi & Itakura, 2011). This entire motor system is present from newborns: Meltzoff and Moore (1977) demonstrated that when babies observe a movement of a member of the same species, they are better able to execute the movement. Once executed, the mental representation of this action is much greater and they are able to perfect the movement because there's mental representation in the praxicon, so, once an action is executed it is able in the motor repertoire.

The MNS has evoked considerable interest in the psychology and neuroscience fields for its role in the mediation and activation of movement (Christensen et al., 2016). Mirror neurons respond when an individual observes and performs an action. That is to say, when the observing individual sees another completing the movement and, by means of a shared perspective, understands what the acting individual is doing, and activation of the MNS occurs. There has been a great deal of research performed to demonstrate the effect that the MNS has upon different types of cognitive processing. Many hypotheses have been presented and tested regarding the role that the MNS plays in imitation, intention, action understanding, empathy, and language processing (Rizzolatti, 2005). Several studies have demonstrated that observers take advantage of their own motor abilities and specific motor cues to predict other people's action (Aglioti, Cesari, Romani & Urgesi, 2008; Ambrosini, Constantini & Sinigaglia, 2011). MNS has received a great deal of attention from specialists and in the scientific and public media. Hailed as "the neurons that shaped civilizations" (Ramachandran, 2009 cited in Cook et al., 2014) it is involved in a wide variety of functions such as action understanding, imitation, language processing, emotion recognition, empathy, intention-reading and language acquisition. In this project, we only focus on action understanding, which will be explained with more details in the next sections.

Electrophysiology of the Mirror Neuron System

Where can we find the MNS in humans? When a visual input enters our system, inferior parietal lobule and inferior frontal gyrus activates, and the activation is much higher when the visual input is an action that exists in our motor repertoire, also called **praxicon** (González-Rothi et al., 1991; González-Rothi, et al., 1997). So, in this sense, the more similar a perceived act resembles another act belonging to the motor repertoire of the observer, the more it tends to induce the execution of the same action (Smith & Kosslyn, 2008). The earliest MNS exploration showed that F5 cells in the premotor cortex in macaque monkeys were activated in response to both self-performance and observation of others performing simple movement tasks (Rizzolatti & Craighero, 2004). In general, fMRI studies in humans reveal consistent activation of the frontal and parietal regions during MNS study (Braadbart, Williams, & Waiter, 2013; Grezes, Armony, Rowe, & Passingham, 2003; Haker, Kawohl, Herwig, & Rössler, 2013). Additionally, magnetoencephalography (MEG) and electroencephalography (EEG) have shown activation of the motor cortex in similar experimentation (Rizzolatti, 2005). It is suggested that perceptual and motor processes share a common neural code (Fox, 2016). Based on their property of firing to both observed and executed actions, it has been hypothesized that the MNS may play a role in human understanding of others' actions and intentions by representing these actions, at a cortical level, for both execution and observation (Fogassi et al., 2005) In EEG testing specifically, the MNS empathetic response is determined by the mu, or sensorimotor rhythm. This is an 8-12 Hz alpha or 12-25 beta frequency band activation in the sensorimotor cortex (Hari & Salmelin, 1997; Rizzolatti & Fabbri-Destro, 2008). While alpha rhythm is normally found when testing regions of the brain such as the occipital cortex (Perry, Stein & Bentin, 2011), **mu rhythms** are found in the sensorimotor cortex, and suppression has been correlated with the empathetic processing of one's actions and the actions of others (Llanos, Rodriguez, Rodriguez-Sabate, Morales, & Sabate, 2013; Kumar, Riddoch & Humphries, 2013; Perry, Stein & Bentin, 2011). The **mu rhythm frequency band** is defined by activity falling between 8 and 13 Hz and recorded by scalp electrodes over the sensorimotor cortex during waking neural activity. The activation of the motor system during action observation of an action has led some researchers to interpret it not only as evidence of a recognition process but also as a means to repeat the observed action and even understand the intention behind it (Rizzolatti & Sinigaglia, 2010).

Cannon and colleagues (2005) found that mirror neurons are goal-directed and specific to personal motor repertory, both of which are key concepts in predicting activation of the MNS in expert populations. They discuss an fMRI-based study performed by Calvo-Merino and colleagues (2005) in which similar ballet and capoeira dance movements were shown to professional ballet and capoeira dancers and to novices. They found that activation of the premotor and parietal areas was greater in the dancers than in the novices. In another reviewed research study, Cross et al., (2011) showed that expert ballet dancers who were taught a sequence of movement over the course of five weeks, showed increased activation when presented with this sequence as opposed to an unfamiliar sequence. This finding suggests that the MNS is susceptible to activation when presented with a personal repertoire learned only recently. The authors also discuss research showing EEG mu suppression in expert populations such as karate experts, air rifle experts, and professional musicians (Cannon et al., 2005). In their study, Cannon et al. (2005) were specifically interested in whether EEG mu suppression would occur for newly learned expertise of tool-use action. Prior to completion of a claw task, the participants were taught the use of the claw through personal practice, taught the use of the claw through observation, or given no training. The findings showed that the active experience group had greater mu rhythm desynchronization than the groups with observational experience or no prior training of the task. This suggests that the MNS is highly sensitive to one's own personal repertoire as would be applicable to the expert ballet dancers in the present study (Cannon et al., 2005). Some studies (Knox, 2009; Gallese, 2013) also included introspective ways to assess MNS activation. They speculated with results obtained that MNS was more active in population primed by the specific action observed or imagined. Motor imagery has been also very studied among MC researchers. Premotor areas and somatosensory brain regions where MNS are located were more active in expert population than in novices or non-dancers. They evaluated MNS using an ordinal measure of action imagination and action comprehension. This is very relevant for this study too, because of the introspective measure to assess activation MNS between groups.

Moreover, recent studies have demonstrated that gaze and fixations patterns can be influenced by the different motor programs in humans. Gaze preferences align well with expectations based on knowledge regarding MNS network structure and function. Increased fixation counts in organic areas of interest (legs, hands, head, arms) are positively related to motor expertise (Claudia et al., 2013; Donaldson, Gurvich & Enticott, 2015). Stevens et al. (2010) concluded in their studies that the brief fixation times characteristics in expert dancers, reflect a rapid perceptual processing guided by expectancies, and motor programs repertoire.

1.1.3. Mirror neurons and dance; recent studies

Dance: definition and implications in cognitive neuroscience

Dance is universal across human cultures and may have emerged as early as 1.8 million years ago. Throughout history, dance has played a pivotal role in cultural and social practices and has also developed into a form of art and entertainment. Dance provides a unique model to investigate how the brain integrates movement and sound as well as the development of motor expertise combined with artistic creativity and performance (Bläsing et al., 2012). Dance can be defined as the movement of one or more modes in a choreographed or improvised manner with or without accompanying sound. Dance involves long-term and intensive practice of sensorimotor skills, and the type and duration of training can be quantified. As such, studying dance offers a unique window to study human brain plasticity and the interaction between the brain and behaviour (Bläsing et al., 2012; Orgs, Dombrowski, Heil, & Jansen-Osmann, 2008). For researchers interested in the integration of movement and cognition, dance is a rich source of material, because it includes several aspects of embodied cognition involved in performing and perceiving dance. This have inspired many researchers to use dance as a means for studying motor control, expertise, and action-perception links (Smith & Kosslyn, 2008; Bläsing et al., 2012). This professional population often learn choreography by watching others perform and by observing their own actions in order to perfect the movements. Related to that manner of learning, research on dance observation has been influenced by studies of the Mirror Neuron System (or action observation network) in primates and humans and in particular, by the idea that this network supports the observation and simulation of others' actions.

During an observational motor learning protocol, learners obtain new motor patterns based on the visual information presented by an execution model. In order to do so, learners have to transform the observed visual information into motor commands, this is called the visuo-motor transformation (Lago-Rodríguez, 2014). Studies (Romani et al., 2005; Maslovat et al., 2010 & Rohbanfard & Proteau, 2011) show that observational motor learning may improve action perception and motor execution. Futhermore, action perception and action execution interact in a mutual and bi-directional fashion (visuo-motor and motor-visual interaction), suggesting that perception and action share common neural mechanisms. Mirror neurons have been proposed as the neurophysiological basis of the visuo-motor and motor-visual transformation processes, and can play a role in the perceptual and motor improvements influenced by observational motor learning.

In this study, classical ballet is the specific movement to work the research question because of the exactitude of the movements and the wider exploration of this type of dance in motor cognition literature. Ballet is a dance category in which the repetition of particular movements is essential. Additionally, dancers are trained to observe the movements performed by their instructors or professionals and mirror them exactly (Vaganova, 2012).

The main interest of this project is to examine if motor expertise can influence in the MNS activation. That is, previous work has indicated that the observation of an action performed by another activates the premotor areas in the brain allowing simulation, or imagery, of the movement to occur as the observer works to understand the movement and perspective of the actor (Calvo-Merino et al., 2005).

1.1.4. Physiological evaluation in psychology

Neurophysiology studies in non-human primates and human neuroimaging studies have provided evidence that observing a simple movement activates the same neural regions used when we execute these movements ourselves (Bläsing, Puttke & Schack, 2018).

In this work, eye tracking technology is used to obtain different data, and it is interesting to mention that this kind of devices is increasingly being used in psychology. Different domains in scientific research can take benefits of eye tracking technology, but cognitive psychology -which studies basic human functions described at the beginning of this paper- can exploit it obtaining physiological data such as reaction time responding tasks, number of fixations, saccadic average velocity and far more (Mele & Federici, 2012).

1.2.Objectives

The present study seeks to further the scientific understanding of the MNS by analysing the behavioural responses following action observation of expert movements. Here it is assumed that observation of visual stimuli to dancers and everyday movements in dancer populations will evoke a MNS response, causing the dancer to interpret the movements faster and representing the movement in their brains. At the same time, expert dancers will be able to recognize if the movements they observe are correctly executed or incorrectly executed. Similarly, it is assumed that the MNS of non-dancers will be primed by everyday movements, but not dancer movements. At the same time, non-dancers won't be able to discriminate if the specific ballet movements are executed correctly. In this study therefore, the aim is to look at the differences in dancer versus non-dancer response following the observation of movements uniquely performed by expert ballet dancers compared to the observation of everyday or innately familiar movements, and also the ability to discriminate the right and wrong specific actions observed.

- **General objective:** To determine from the data obtained in this study and from recent literature, whether the MNS is more activated in expert dancers while action observation, in comparison with non-dancers.
- **Specific objective (1):** To establish, that action comprehension is significantly correlated with subject's prior experience.
- **Specific objective (2):** To determine if there's significantly, more error detection in the experimental group in comparison with the control group.

1.3. Hypothesis

Following the studies presented in the previous sections, here are presented different postulations:

- **Hypothesis 1:** Observation of ballet movements and everyday movements will result in the highest MNS activation in expert dancers, due to the familiarity of the actions, in comparison with control group.
- **Hypothesis 2:** Fixation duration of the expert dancers will be significantly shorter compared to non-dancers. As Stevens et al., (2010) concluded, it's assumed that the results with the Eye-Tracker apparatus in this work will be very similar to the results of the research mentioned.

2. Methods

2.1. Participants

Selection criteria for participants were: They had to be adult women, right-handed and with no psychopathology or medication taking that could affect their perceptual capacities. For the expert dancers it was necessary that they were at least in their fourth year of ballet practising and their practice was regular (at least once a week). For the non-dancers was necessary that they didn't have experience in ballet or other type of dances. Fifteen adult women presented volunteers, but two of them were discarded because they were ballerinas in the past and they don't practise ballet in the present time and three of them were left-handed. Finally, ten adult females aged 18-35 years (*M*= 21,6, SD= 4,9) passed the selection criteria. Five participants were expert ballet dancers and the rest of them do not have any type of experience in ballet or other type of dance (see table 1). The subjects presented volunteers for this work through a poster via social media, where it was specified the objective of this project and that all collected data would remain anonym. All participants were university students, right-handed and don't have any psychopathology or medication taking that could have affected their perceptual capacities. The participants are divided in two groups: control group (non-expert) and experimental group (expert dancers).

2.2. Psychological assessment and expertise level

In this project, to dismiss psychopathology, the Symptom Checklist 90 Revised (SCL-90-R) (Derogatis, 1975) was used. The SCL-90-R is one of the most widely used instruments for measuring psychopathological symptomatology in clinical and nonclinical population. The definitive version of the SCL-90-R assesses psychological symptoms and distress through 90 items that make up nine primary dimensions and three global indexes. The reliability of the scale among Spanish population turns out to be very acceptable, with some coefficients of internal consistency of the ten dimensions, which oscillate between .69 and .97 (Caparrós-Caparrós et al., 2007). All participants that obtain a punctuation bellow 75 in general distress global scale are considered that don't have risk to have any psychopathology (Caparrós-Caparrós et al., 2007).

The Edinburgh Handedness Inventory (EHI) is a 10-item index of a person's left- or right-hand dominance in everyday activities, such as writing or using cutlery (Oldfield, 1971). It is the most widely used such measure (Fazio et al., 2011), and possesses strong psychometric properties with a "very high internal consistency and adequate composite reliability and convergent validity" in the Spanish version (Albayay, 2019).

The expertise questionnaire developed by Amoruso et al., (2014) was used to evaluate the competences of the subjects in specific types of movements related to ballet dance, and also action comprehension and autoperception of the level of expertise.

2.3. Stimuli selection

For each task, different YouTube videos were selected. For the Eye-Tracker task, in total four 1-minute clips were selected: two short ballet clips that include movements such as *Pliés* and *Tendus in 5th* executed on the right; and two short usual movements as *running* and *walking* were also included.

For the EEG task, a video of professional ballet experts teaching the rights and wrongs in expert ballet movements was selected for the choice of visual stimuli. In total, 80 clips of five seconds each were extracted. 40 of them concerned performing ballet steps correctly, and 40 of them incorrectly. All stimuli were in black & white, similar to the experimental design seen in Amoruso et al., (2014).

YouTube links of all stimuli used can be found in the annexes.

2.4. Experimental task

2.4.1. Eye Tracker Recording

Tobii TL120 Series was used for Eye Tracker Recording. Different areas of interest were codified. Organic body parts for one the one hand and on the other hand inorganic parts like the different backgrounds were also selected as areas of interest to assess the number of fixations of each participant.

2.4.2. Conductual Task Recording

SuperLab 5.0 was the program used to carry out the conductual task. A 24 inches screen, Cedrus Data Viewer, and a Cedrus Response Pad model RB-420 were used to execute the experiment.

2.5. Procedure

The procedure is developed in two sessions: in the first one, the participants sign an informed consent and respond to the set of tests through the Google Forms platform. A total of 15 women presented volunteers to the study; five were discarded because two of them where ballerinas in the past and they couldn't fit in any group; and three of the discarded volunteers were left-handed. In total, ten participants passed the selection criteria and individually came to the laboratory of psychology to make the conductual tasks in the second session. The second session was organized to be a face-to-face meeting at the laboratory of Psychology of the Faculty of Education and Psychology from the University of Girona. The session was organized in the following way: first the participants followed the COVID19 protocols to make the experiments with the security measures; and afterthought they signed the informed consent. I also gave them the Symptom-Checklist-90 results because they were interested in their general distress results. Then each participant sat in front of the eye tracker apparatus and we calibrated their gazes together. They sat at 60cm from the screen, measured with the eyetracker itself. Once the gaze is calibrated, I entered the participant codes and when they were ready, they pressed the space button to start viewing the videos. After they watched the videos, they entered the faraday cabin to respond the conductual task. They sat at 60cm from the screen and after the task was explained, they started watching the 5s clips. First 3 clips were for training and let the participants understand the dynamic of the task. Once the training was finished, they could choose if start the 80 clips task or restart from the beginning the training. Finishing each clip, a black screen with white words appeared to arouse a response as it is showed in the next figure. After they finished the task a reward for participation was given. The visual stimuli were presented pseudorandomly and counterbalanced.

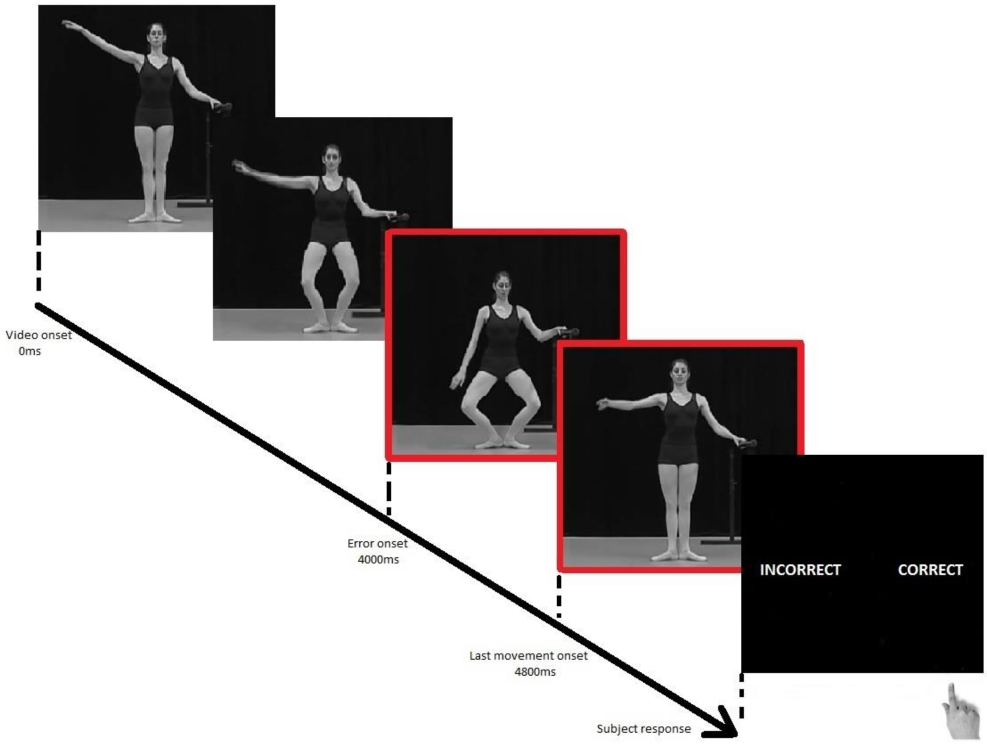


Figure 2. *Visual stimuli were presented pseudorandomly (participants received the instruction that correct and incorrect movements appeared randomly, but only the experimenter knew that were presented counterbalanced). Subjects had to respond if the movements observed were incorrect or correct with the Cedrus Response Pad.*

2.6. Data analysis

Descriptive data was used to get the general idea of the means and standard deviation of the different variables among participants. In terms of inferential statistics, independent samples Mann-Whitney *U* tests were used to assess differences between Groups. Subsequent Spearman correlations to evaluate associations between variables studied were realised. Also, two linear regressions to assess the predictors of one dependent variable were used.

3. Results

The results from the study were analyzed in order to prove and examine the objectives and hypothesis explained. In the first section descriptive statistics are presented and after that all inferential statistics done are showed and described. All statistical analyses were performed in SPSS (Version 25.0).

3.1. Descriptive statistics

Here below, means and standard deviations of the different variables analyzed are presented. Descriptive statistics of each group and the total for all participants are showed.

Table 1. *Frequencies of time spent dancing ballet (motor expertise)*

GROUP		Years spent dancing ballet	Hours a week dancing ballet	Hours per month dancing ballet	Hours a week dancing for fun	Hours a week teaching ballet
Control	Mean	,00	,00	,00	3,10	,00
	N	5	5	5	5	5
	Standard Deviation	,000	,000	,000	1,949	,000
Experimen-tal	Mean	13,20	12,80	43,80	2,60	5,60
	N	5	5	5	5	5
	Standard Deviation	6,301	7,259	33,199	4,219	10,431
Total	Mean	6,60	6,40	21,90	2,85	2,80
	N	10	10	10	10	10
	Standard Deviation	8,127	8,303	31,981	3,110	7,554

Table 2. *Frequencies of Action familiarity variables*

GROUP		Autoperceptio n ballet	Action comprehension	Action imagination execution	Action executation
Control	Mean	,00	1,20	1,00	1,00
	N	5	5	5	5
	Standard Deviation	,000	,447	,000	,000
Experimental	Mean	4,20	5,00	5,00	4,40
	N	5	5	5	5
	Standard Deviation	,447	,000	,000	,548
Total	Mean	2,10	3,10	3,00	2,70
	N	10	10	10	10
	Standard Deviation	2,234	2,025	2,108	1,829

Table 3. *Frequencies of Fixation counts*

GROUP		Total counts *Pliés*	Total counts *Tendus in 5th*	Total counts *Running*	Total counts *Walking*
Control	Media	152,80	65,80	8,80	69,80
	N	5	5	5	5
	Desv. Desviación	26,621	9,576	3,271	14,149
Experimental	Media	172,80	71,00	6,80	67,60
	N	5	5	5	5
	Desv. Desviación	33,372	22,650	1,483	21,939
Total	Media	162,80	68,40	7,80	68,70
	N	10	10	10	10
	Desv. Desviación	30,349	16,621	2,616	17,442

Table 4. *Frequencies of fixation perimeter and saccades duration*

GROUP		Saccades average duration	Fixation perimeter
Control	Mean	1672,7040	34,60
	N	5	5
	Standard Deviation	2328,11480	3,209
Experimental	Mean	827,1340	14,20
	N	5	5
	Standard Deviation	341,67437	4,147
Total	Mean	1249,9190	24,40
	N	10	10
	Standard Deviation	1630,77729	11,306

Table 5. *Frequencies of Errors detected and Reaction time*

GROUP		Number of errors detected (total = 40)	Reaction time responding conductual task (ms)	Reaction time responding conductual task, when answer correct (ms)	Reaction time responding conductual task, when answer error (ms)
Control	Mean	15,20	1119,356220	1104,7880	1225,0660
	N	5	5	5	5
	Standard Deviation	3,347	271,3628117	351,95929	309,78412
Experimental	Mean	38,80	141,600000	96,4420	128,0260
	N	5	5	5	5
	Standard Deviation	1,095	27,1485432	36,77692	35,32562
Total	Mean	27,00	630,478110	600,6150	676,5460
	N	10	10	10	10
	Standard Deviation	12,658	546,4549733	581,45561	614,41917

3.2. Comparison of group means

As it was mentioned before, Mann-Whitney *U* tests were performed to compare means between groups.

In Table 6 it’s seen that there are significant statistical differences between groups in all categories except on the time spent dancing for fun, and time dedicated teaching ballet, in which there are no differences between experimental and control group.

Table 6. *NPAR Mann Whitney U Test; Expertise Dance Questionnaire items*

	Group	**N**	**Mean rank**	**Z**	**Significance (*p*)**
Years spent dancing ballet	Control Experimental	5 5	3 8	-2,785	,005**
Hours a week dancing ballet	Control Experimental	5 5	3 8	-2,785	,005**
Hours per month dancing ballet	Control Experimental	5 5	3 8	-2,785	,005**
Years receiving formal classes	Control Experimental	5 5	3 8	-2,785	,005**
Hours a week dancing for fun	Control Experimental	5 5	6,5 4,5	3.11	,292
Hours a week teaching ballet	Control Experimental	5 5	4,5 6,5	7.55	,136
Autoperception level ballet	Control Experimental	5 5	3 8	-2,887	,004**
Action comprehension	Control Experimental	5 5	3 8	-2,887	,004**
Action executation	Control Experimental	5 5	3 8	-2,835	,003**
Action imagination execution	Control Experimental	5 5	3 8	-2,835	,005**

**p<0,01

* p<0,05

In Table 7 it is notable that there are no significant differences between groups in terms of fixations. But as we can see, there’s one result that shows statistical differences; referent to the fixation counts of the right arm when the participants observe the *Tendu* movement. We also can see that there are two more results that are proximately to significance; left arm and legs are two areas where there could be statistically significant differences that will be interesting to further explore.

Table 7. *NPAR Mann Whitney U Test; Fixations*

	Group	N	Mean Rank	Z	Significance (*p*)
Fixation count Left Arm *Plié*	Control Experimental	5 5	6,4 4,6	-1,809	,07
Fixation count Legs *Plié*	Control Experimental	5 5	6,2 4,8	-1,781	,075
Fixation count Right Arm *Tendu*	Control Experimental	5 5	3,7 7,3	-1,965	,049*

*p<0,05

On the contrary, in terms of fixation perimeter we can see significant differences between groups, concretely, fixation perimeter is wider in non-dancers than expert dancers.

Table 8. *NPAR Mann Whitney U test; saccade's average duration and fixation perimeter*

	Group	N	Mean Rank	Z	Significance (*p*)
Saccade's duration	Control Experimental	5 5	5,2 5,8	-1,313	,754
Fixation perimeter	Control Experimental	5 5	8 3	-2,619	,009**

**p<0,001

Next, in table 9 we can see significant statistical differences between groups; experimental group detected way more errors than control group. On the other hand, reaction average time was significantly lower in experimental group in comparison with control group.

__Table 9.__ NPAR Mann Whitney U Test; Reaction Time and Errors Detected

	Group	N	Mean Rank	Z	Significance (*p*)
N errors detected (total=40)	Control	5	3	-2,643	,008**
	Experimental	5	8		
Reaction average time of response (ms)	Control	5	8	-2,611	,009**
	Experimental	5	3		
Reaction average time responding when correct movement is presented	Control	5	6,2	-,731	,009**
	Experimental	5	4,8		
Reaction average time responding when incorrect movement is presented	Control	5	5,6	-,104	,009**
	Experimental	5	5,4		

**p<0,01

3.3. Spearman correlations

In the next tables we can see Spearman correlations between variables; it is notable the significant correlations within the time spent dancing ballet and the number of errors detected. There's an inverse correlation between the variables time spent dancing and reaction time responding. The same for hours a week dedicated to ballet and reaction time. In table 10 all correlations are statistically significant; so, we can see that the more time spent dancing ballet (years dancing; hours dedicated per month/per week), the more errors individuals can detect when they observe movements; and the less time will spend responding if the movement observed is correct or incorrect.

Table 10. *Correlations between time spent dancing and average RT*

			Reaction time responding conductual task (ms)	Years spent dancing ballet	Hours a week dancing ballet
Spearman Rho	Reaction time responding conductual task (ms)	Correlations Coefficient	1,000	-,782**	-,756*
		Sig. (bilateral)	.	,007	,011
		N	10	10	10
	Years spent dancing ballet	Correlations Coefficient	-,782**	1,000	,917**
		Sig. (bilateral)	,007	.	,000
		N	10	10	10
	Hours a week dancing ballet	Correlations Coefficient	-,756*	,917**	1,000
		Sig. (bilateral)	,011	,000	.
		N	10	10	10

**p < 0,001

*p < 0,005

In Table 11 we can observe that all correlations are statistically significant; so, summarizing we can assume that the more familiarity with movements observed and the more capacity to imagine oneself making the execution of actions the more capable will individuals be to detect errors during action observation; and the less time will spend responding whether the actions observed are correct or incorrect. The correlations between action familiarity variables are direct and the correlations within action familiarity variables and RT responding are inverse.

Table 11. *Correlations between action familiarity and average RT*

			Action comprehen-sion	Action imagination execution	Action executation	Reaction time responding conductual task (ms)
Spearman Rho	Action comprehension	Correlations Coefficient	1,000	,962**	,909**	-,804**
		Sig. (bilateral)	.	,000	,000	,005
		N	10	10	10	10
	Action imagination execution	Correlations Coefficient	,962**	1,000	,945**	-,870**
		Sig. (bilateral)	,000	.	,000	,001
		N	10	10	10	10
	Action executation	Correlations Coefficient	,909**	,945**	1,000	-,822**
		Sig. (bilateral)	,000	,000	.	,003
		N	10	10	10	10
	Reaction time responding conductual task (ms)	Correlations Coefficient	-,804**	-,870**	-,822**	1,000
		Sig. (bilateral)	,005	,001	,003	.
		N	10	10	10	10

**p < 0,001

*p < 0,005

The following table is determinant for future conclusions. In here, we can see that action comprehension is significantly modulated by subject's prior experience; so, the more time individuals have spent dancing ballet, the more they will comprehend actions they observe. It's also notable that the correlation is higher between years dancing ballet and action imagination execution, so in conclusion, the more time subjects have been dancing ballet the more able will be to imagine themselves executing that specific movements. All correlations showed in the next table have a direct relation between variables.

Table 12. Correlations between action familiarity and time spent dancing

			Years spent dancing ballet	Action comprehension	Action imagination execution
Spearman Rho	Years spent dancing ballet	Correlations Coefficient	1,000	,893**	,928**
		Sig. (bilateral)	.	,000	,000
		N	10	10	10
	Action comprehension	Correlations Coefficient	,893**	1,000	,962**
		Sig. (bilateral)	,000	.	,000
		N	10	10	10
	Action imagination execution	Correlations Coefficient	,928**	,962**	1,000
		Sig. (bilateral)	,000	,000	.
		N	10	10	10

**p < 0,001

*p < 0,005

In the last correlation, we can see a negative relation between the fixation perimeter and action imagination. The tendency shows that the more action imagination an individual has, the less fixation perimeter will result when observing ballet movements. So, the relationship between variables is inverse.

Table 13. *Correlation between action imagination and fixation perimeter*

			Action imagination execution	Fixation perimeter
Spearman Rho	Action imagination execution	Correlation coefficient	1,000	-,870**
		Sig. (bilateral)	.	,001
		N	10	10
	Fixation perimeter	Correlation coefficient	-,870**	1,000
		Sig. (bilateral)	,001	.
		N	10	10

**p < 0,001

*p < 0,005

3.4. Linear regressions

In the next table we can see a linear regression using the method step-wise to select the best predictors of the dependent variable. The dependent variable was *Reaction Time responding conductual task*. The variables introduced were: EDQ items; Fixation counts and number of errors. The best model obtained included only one predictor which is the *number of errors detected* while AO. The relationship between the dependent variable and the unique predictor is negative; and it's important to take into account that it's statistically significant. Adjusted R^2 for the best model was ,892. With these results we can interpret that the number of errors detected determine RT responding if the movements observed are correct or incorrect, the greater number of errors individuals can detect, the less time will be spent responding.

Table 14. *LINEAR REGRESSION*

Unstandardized coefficients				**Standardized coefficients Beta**	t	Sig.	Collinearity statistics	
Model		B	Error Deviation				Tolerance	VIF
1	Constant	1738.75	139.72		12.444	0.000		
	Number of errors detected	-41.04	4.729	-0.951	-8.681	0.000	1,000	1,000

**Dependent variable: Reaction time responding conductual task*

In table 15 other linear regression is presented with the step-wise method to select the best predictors of the dependent variable. The dependent variable is *action imagination execution.* Variables entered were: EDQ items, Fixation counts, saccades average duration, fixation perimeter and reaction time responding conductual task. Only one of these variables entered the best model, and we can see there's statistical significance of this predictor on the dependent variable. Adjusted R^2 for the best model was ,976. It is notable that the constant has not statistical significance for this model, so it is only included the variable *Action comprehension.* This means that the more action comprehension of actions observed an individual have, the more capacity to imagine oneself executing that action will have.

Table 15. *LINEAR REGRESSION*

Unstandardized coefficients				**Standardized coefficients Beta**	t	Sig.	Collinearity statistics	
Model		B	Error Deviation				Tolerance	VIF
1	Constant	-,192	,198		-,973	,359		
	Action Comprehension	1,03	,054	,989	19	,000	1,000	1,000

**Dependent variable: Action imagination observation*

4. <u>Discussion</u>

Through the Mann-Whitney *U* test performed, there were some findings that can provide us further evidence to higher activation of the MNS, specially in expert ballet dancer population. First, action imagination in dancer population was higher than the non-dancers, so this means that ballerinas could imagine themselves practicing actions observed while action observation. In terms of average time, we can see in the mean ranks that the dancer population was faster responding if movements observed were correct or incorrect. With results obtained it is also demonstrated that the more action comprehension an individual has, the more capacity to imagine themselves executing actions observed they will have. This is related with various studies results (Stevens & McKechnie, 2005; Aridan et al., 2018; Hardwick et al., 2018 & Scott et al., 2018), that concluded there's evident interrelation between neural mirroring and motor expertise. AO engages sensorimotor and premotor areas where the MNS is located, and so, RT differences between groups and error detection could be explained by accessibility to motor programs and subsequently by activity of sensorimotor cortex and premotor areas during action observation.

In terms of Eye Tracker Data, it is notable that there are no significant results in terms of fixations. Both groups non-dancers and expert dancers fixate the same areas and fixations last statistically similar. The same for the two types of stimuli presented: specific ballet movements and everyday movements. These results are contrary to which initially we expected. Otherwise, there are some other studies (Amoruso et al., 2014; Sarpeshkar, Abernethy, & Mann, 2017; Klostermann, & Hossner, 2018) that concluded there are no significant differences in terms of fixations and saccades between non-dancers and dancers. It is relevant to highlight that the differences in methodology, variations in experimental designs and also in the data analysis, which leads to different results and subsequent dissimilar conclusions between studies. After all, eye tracking results concerning motor expertise are controversial and for the moment we can't see a clear path in such a manner that can link data analyzed with eye tracker technology and motor expertness concerning MNS activation. As a consequence of dissimilarities in literature, we also extracted data regarding the fixation perimeter which resulted a very interesting variable. In table 8 it's showed the significant differences between groups in terms of fixation perimeter, this could mean that ballerinas fixate in specific points and perceive in a way to understand what they are watching. Non-dancers, instead, observe in an arbitrary way and don't focus on the specific movements in a manner to understand. Fixation perimeter is a variable studied in medicine sciences and specific physics field, and would be helpful to apply this type of measure in Cognitive Psychology.

Spearman correlations also gave us results that come along the main research question: the more motor expertise a subject have in specific movements, the more MNS activation will have. With these results it is hypothesized that MNS is more activated in expert ballet dancers than non-dancers. Our introspective type of measures demonstrated the interrelation between these two variables: the more a subject dedicates to specific movements, the more capacity to comprehend the movements observed will have, and the more ability to imagine oneself executing that specific movements. This can be explained through the representation of movements in the motor repertoire: ballerinas have mental representations of the actions observed so they have accessibility to that specific motor programs. In contrast, non-dancers don't have any representation in their motor repertoire of the actions observed. The same explanation to the Error Detection (ED) results: expert ballet dancers could recognize in their motor repertoire the movements presented, so they knew if movements were correct or incorrect. In terms of RT, non-dancers gave arbitrary responses and needed more time to analyze, and decide if the action presented was executed correct or incorrect. Herebefore, was mentioned that ballet is such an exact type of dance often compared with mathematics, so only ballerinas that have more than four years of experience and regular practice of classical ballet can discriminate the wrongs and the rights of the movements observed (Calvo-Merino et al., 2005).

It is remarkable in the correlations done that motor expertise is a good predictor for error detection. As we've could see, the more experience in ballet a participant has, the more errors will be able to detect. This is related with Amoruso et al., (2014) and Amoruso et al., (2017) studies. They were the first authors providing a causal model that connects expertise with understanding of the movements observed, and they found out that motor expertise is a good predictor of error detection. Also, these studies support our hypothesis of the activation pattern of mirror neuron system: somatosensory areas are more active among expert dancers than non-dancers or beginners (Calvo-Merino at al., 2005; Amoruso et al., 2014; 2017). Also, the last linear regression performed demonstrated that action imagination predicts action comprehension. In this work, MNS was measured through an introspectively way: action imagination was the manner to assess MNS activation. And we could see that action comprehension is predicted by action imagination. In the same path, spearman correlations demonstrated that action comprehension was significantly modulated by subject's prior experience so in conclusion, expert ballet dancers have a higher activation in the mirror neuron system (somatosensory and premotor areas) in comparison with non-dancers. Anyway, it is very important to take into account that all conclusions have to be interpreted with caution, because of different limitations explained hereafter.

5. Limitations and future research lines

The present study is not without limitations. On the first time, electroencephalography was going to be used to assess MNS activation. Different schedule incompatibilities happened and only eye tracking and conductual task were used. For that reason, this study focuses on action imagination as a measure of MNS activation. This leads to different limitations, because it is not seen the activation of the specific brain areas we wanted to explore. First of all, we can't see causal relationship between variables explored, in this study conclusions are only inferential and hypothesized according to the results obtained and recent literature that support them. Another limitation is the sample size. Different psychophysiological studies agree with that the minimum sample size to obtain more valid data is twenty participants (Guttman et al., 2019). So, results obtained in this study can bright the path that MNS activation follows according with motor expertise, but more studies in this field are necessary.

It would be interesting to further explore hypothesis raised in this project with a bigger sample size, and dividing the participants in three different groups in accordance with the grade of motor expertise they could be classified. A small sample size leads to low valid results and differences between groups are not very clear. Anyway, it is important to highlight that in any study that includes psychophysiology analysis it is difficult to maintain participants engaged with experiments, and so it is very relevant to contact them once the experimental design is completely prepared. Also, including frequencies analysis or Event Related Desynchronization with Electroencephalography could give more valid results to analyze the processes underlying MNS activation.

Other interesting type of analysis that could be complemented in the future is MATLAB statistics toolbox to assess eye tracking data. Different studies show divers type of analysis in this type of data, and maybe this leads to dissimilar paths and to the controversy among eye tracking results regarding motor cognition. For example; Amoruso et al., (2014) & Amoruso et al., (2017) showed non-significant effects in their results. On the contrary, Stevens et al., (2010) showed very interesting differences among groups. Anyway, it could be compelling to replicate these experiments and get clearer conclusions within these eye tracking variables.

5.1. Implications of AO

Concreteley, the development and discoveries related to MNS functioning has helped to develop different interventions in distinct fields of psychology; from clinical psychology (Shafir, 2016) to educational psychology (Van Gog et al., 2009; Dash et al., 2019), applying AO therapies to evoke, process and regulate specific emotions or applying observational learning among kids in school.

The study of the MNS activation among motor expert population has also helped to develop new therapies in neuropsychology. This field is responsible for rehabilitation of the cognitive functions, in terms of substitution, restoration and compensation of the functions lost (Andrewes, 2015). Different studies (Franceschini et al., 2010; Yuan et al., 2015 & Zhang et al., 2018) concluded that action observation treatment, concretely Mirror Neuron Therapy may become a useful strategy in the rehabilitation of stroke patients, also in neurodevelopmental disorders (such as Autistic Spectrum Disorder) and neurodegenerative diseases (especially the ones related with motor deficiencies). Anyway, this type of interventions should be more studied in order to get better therapies adjusted to problematics that needs intervention in motor skills and the empathy related to the MNS functioning.

6. Conclusions

The main objective of this bachelor's thesis was to analyze if motor expertise could influence in the activation of a wide group of neurons called Mirror Neurons. The Mirror Neuron System (MNS) was discovered serendipity by three Italian neuroscientists on the 1996. They concluded that observing and executing actions were very similar actions represented in macaque monkey's brains. This great discovery has been studied by neuroscientist over the last decades, and has had a remarkable impact among cognitive psychologists and neuropsychologist that study motor deficiencies.

This bachelor's thesis obtained some interesting results with an introspective type of measure for the MNS activation, summarizing the results, it showed that motor expertise is a good predictor of action comprehension and action imagination. This means that the more experience a person has in specific movements, the more ability to comprehend the actions observed and the more capacity to imagine oneself executing that specific movements will have. This is very relevant because the main function of the MNS is to represent the movements observed in somatosensory and premotor areas, without sending signals to the motor areas and consequentially inhibiting the execution of that movements.

It has been demonstrated that Action Observation could have a great impact among stroke survivals, Parkinson's disease and Alzheimer's disease patients because of the rehabilitation of specific areas related to motor skills (Yuan et al., 2015 & Zhang et al., 2018). Some studies have also shown that AO therapies could help to treat different aspects such as emotion regulation (Yuan & Hoff, 2008; Shafir, 2016) and interventions with lack of empathy in some patients, for example in people with Autistics Spectrum Disorder (Holmwood, 2017).

Limitations were present along the project, but problem solving and adaptation to situations were fundamental to continue this idea. Future research lines can be purposed in a wide variety of psychology fields; for example, it would be very interesting to also explore the inhibition of actions while AO and find relations with specific personality patterns. This could be an interesting research line for the application of the AO therapy in clinical psychology; taking into account that AO therapy could be adjusted to different type of personalities. Anyway, this idea could be further explored to adjust to the different demands of the population, and that us, as psychologist could help.

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Abreviations: MNS (Mirror Neuron System), AO (Action Observation), RT (Reaction Time), MC (Motor Cognition) Error Detection (ED), Expertise Dance Questionnaire (EDQ), Edinburgh Handedness Inventory (EHI)

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9. Annexes

- **YouTube links to stimuli used**:
  Eye Tracker stimuli:
  https://www.youtube.com/watch?v=ZSIfgTOowYk&pp=ugMICgJlcxABGAE%3D

  SuperLab Stimuli: https://www.youtube.com/watch?v=TDNenI-eF5o

- **Figures**

Fig1. Visual scheme of cognitive psychology (Gazzaniga & Heatherton, 2015).

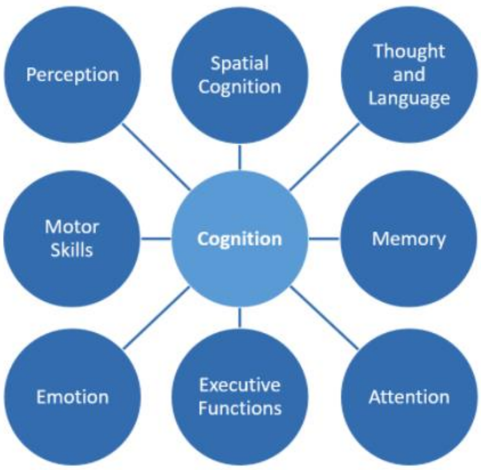
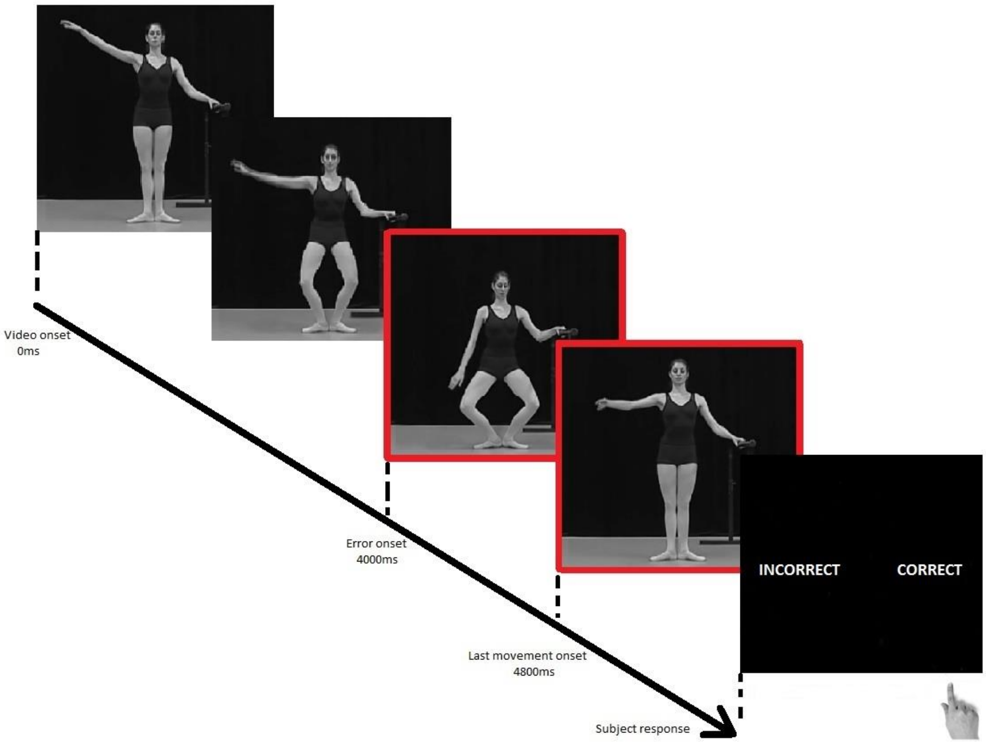


Figure 2. *Conductual task*



- **Tables**

Table 1. *Frequencies of time spent dancing ballet*

GROUP		Years sent dancing ballet	Hours a week dancing ballet	Hours per month dancing ballet	Hours a week dancing for fun	Hours a week teaching ballet
Control	Mean	,00	,00	,00	3,10	,00
	N	5	5	5	5	5
	Standard Deviation	,000	,000	,000	1,949	,000
Experimen-tal	Mean	13,20	12,80	43,80	2,60	5,60
	N	5	5	5	5	5
	Standard Deviation	6,301	7,259	33,199	4,219	10,431
Total	Mean	6,60	6,40	21,90	2,85	2,80
	N	10	10	10	10	10
	Standard Deviation	8,127	8,303	31,981	3,110	7,554

Table 2. *Frequencies of Action familiarity variables*

GROUP		Autoperception ballet	Action comprehension	Action imagination execution	Action executation
Control	Mean	,00	1,20	1,00	1,00
	N	5	5	5	5
	Standard Deviation	,000	,447	,000	,000
Experimental	Mean	4,20	5,00	5,00	4,40
	N	5	5	5	5
	Standard Deviation	,447	,000	,000	,548
Total	Mean	2,10	3,10	3,00	2,70
	N	10	10	10	10
	Standard Deviation	2,234	2,025	2,108	1,829

Table 3. *Frequencies of Fixation counts*

GROUP		Total counts *Pliés*	Total counts *Tendus in 5th*	Total counts *Running*	Total counts *Walking*
Control	Media	152,80	65,80	8,80	69,80
	N	5	5	5	5
	Desv. Desviación	26,621	9,576	3,271	14,149
Experimental	Media	172,80	71,00	6,80	67,60
	N	5	5	5	5
	Desv. Desviación	33,372	22,650	1,483	21,939
Total	Media	162,80	68,40	7,80	68,70
	N	10	10	10	10
	Desv. Desviación	30,349	16,621	2,616	17,442

Table 4. *Frequencies of fixation perimeter and saccades duration*

GROUP		Saccades average duration	Fixation perimeter
Control	Mean	1672,7040	34,60
	N	5	5
	Standard Deviation	2328,11480	3,209
Experimental	Mean	827,1340	14,20
	N	5	5
	Standard Deviation	341,67437	4,147
Total	Mean	1249,9190	24,40
	N	10	10
	Standard Deviation	1630,77729	11,306

Table 5. *Frequencies of Errors detected and Reaction time*

GROUP		Number of errors detected (total = 40)	Reaction time responding conductual task (ms)	Reaction time responding conductual task, when answer correct (ms)	Reaction time responding conductual task, when answer error (ms)
Control	Mean	15,20	1119,356220	1104,7880	1225,0660
	N	5	5	5	5
	Standard Deviation	3,347	271,3628117	351,95929	309,78412
Experimental	Mean	38,80	141,600000	96,4420	128,0260
	N	5	5	5	5
	Standard Deviation	1,095	27,1485432	36,77692	35,32562
Total	Mean	27,00	630,478110	600,6150	676,5460
	N	10	10	10	10
	Standard Deviation	12,658	546,4549733	581,45561	614,41917

Table 6. *NPAR Mann Whitney U Test; Expertise Dance Questionnaire items*

	Group	N	Mean rank	Z	Significance (*p*)
Years spent dancing ballet	Control Experimental	5 5	3 8	-2,785	,005**
Hours a week dancing ballet	Control Experimental	5 5	3 8	-2,785	,005**
Hours per month dancing ballet	Control Experimental	5 5	3 8	-2,785	,005**
Years receiving formal classes	Control Experimental	5 5	3 8	-2,785	,005**
Hours a week dancing for fun	Control Experimental	5 5	6,5 4,5	3.11	,292
Hours a week teaching ballet	Control Experimental	5 5	4,5 6,5	7.55	,136
Autoperception level ballet	Control Experimental	5 5	3 8	-2,887	,004**
Action comprehension	Control Experimental	5 5	3 8	-2,887	,004**
Action executation	Control Experimental	5 5	3 8	-2,835	,003**
Action imagination execution	Control Experimental	5 5	3 8	-2,835	,005**

**p<0,01

Table 7. *NPAR Mann Whitney U Test; Fixations*

	Group	N	Mean Rank	Z	Significance (*p*)
Fixation count Left Arm *Plié*	Control Experimental	5 5	6,4 4,6	-1,809	,07
Fixation count Legs *Plié*	Control Experimental	5 5	6,2 4,8	-1,781	,075
Fixation count Right Arm *Tendu*	Control Experimental	5 5	3,7 7,3	-1,965	,049*

*p<0,05

Table 8. *NPAR Mann Whitney U test; saccade's average duration and fixation perimeter*

	Group	N	Mean Rank	Z	Significance (*p*)
Saccade's duration	Control	5	5,2	-1,313	,754
	Experimental	5	5,8		
Fixation perimeter	Control	5	8	-2,619	,009**
	Experimental	5	3		

**p<0,01

Table 9. *NPAR Mann Whitney U Test; Reaction Time and Errors Detected*

	Group	N	Mean Rank	Z	Significance (*p*)
N errors detected (total=40)	Control	5	3	-2,643	,008**
	Experimental	5	8		
Reaction average time of response (ms)	Control	5	8	-2,611	,009**
	Experimental	5	3		
Reaction average time responding when correct movement is presented	Control	5	6,2	-,731	,009**
	Experimental	5	4,8		
Reaction average time responding when incorrect movement is presented	Control	5	5,6	-,104	,009**
	Experimental	5	5,4		

**p<0,01

Table 10. Correlations between time spent dancing and average RT

			Reaction time responding conductual task (ms)	Years spent dancing ballet	Hours a week dancing ballet
Spearman Rho	Reaction time responding conductual task (ms)	Correlations Coefficient	1,000	-,782**	-,756*
		Sig. (bilateral)	.	,007	,011
		N	10	10	10
	Years spent dancing ballet	Correlations Coefficient	-,782**	1,000	,917**
		Sig. (bilateral)	,007	.	,000
		N	10	10	10
	Hours a week dancing ballet	Correlations Coefficient	-,756*	,917**	1,000
		Sig. (bilateral)	,011	,000	.
		N	10	10	10

**p < 0,001

*p < 0,005

Table 11. *Correlations between action familiarity and average RT*

			Action comprehen-sion	Action imagination execution	Action executation	Reaction time responding conductual task (ms)
Spearman Rho	Action comprehension	Correlations Coefficient	1,000	,962**	,909**	-,804**
		Sig. (bilateral)	.	,000	,000	,005
		N	10	10	10	10
	Action imagination execution	Correlations Coefficient	,962**	1,000	,945**	-,870**
		Sig. (bilateral)	,000	.	,000	,001
		N	10	10	10	10
	Action executation	Correlations Coefficient	,909**	,945**	1,000	-,822**
		Sig. (bilateral)	,000	,000	.	,003
		N	10	10	10	10
	Reaction time responding conductual task (ms)	Correlations Coefficient	-,804**	-,870**	-,822**	1,000
		Sig. (bilateral)	,005	,001	,003	.
		N	10	10	10	10

**p < 0,001

*p < 0,005

Table 12. *Correlations between action familiarity and time spent dancing*

			Years spent dancing ballet	Action comprehens ion	Action imagination execution
Spearman Rho	Years spent dancing ballet	Correlations Coefficient	1,000	,893**	,928**
		Sig. (bilateral)	.	,000	,000
		N	10	10	10
	Action comprehension	Correlations Coefficient	,893**	1,000	,962**
		Sig. (bilateral)	,000	.	,000
		N	10	10	10
	Action imagination execution	Correlations Coefficient	,928**	,962**	1,000
		Sig. (bilateral)	,000	,000	.
		N	10	10	10

**p < 0,001

*p < 0,005

Table 13. *Correlation between action imagination and fixation perimeter*

			Action imagination execution	Fixation perimeter
Spearman Rho	Action imagination execution	Correlation coefficient	1,000	-,870**
		Sig. (bilateral)	.	,001
		N	10	10
	Fixation perimeter	Correlation coefficient	-,870**	1,000
		Sig. (bilateral)	,001	.
		N	10	10

**p < 0,001

*p < 0,005

Table 14. *LINEAR REGRESSION*

Unstandardized coefficients				**Standardized coefficients Beta**	t	Sig.	Collinearity statistics	
Model		B	Error Deviation				Tolerance	VIF
1	Constant	1738.75	139.72		12.444	0.000		
	Number of errors detected	-41.04	4.729	-0.951	-8.681	0.000	1,000	1,000

**Dependent variable: Reaction time responding conductual task*

Table 15. *LINEAR REGRESSION*

Unstandardized coefficients				**Standardized coefficients Beta**	t	Sig.	Collinearity statistics	
Model		B	Error Deviation				Tolerance	VIF
1	Constant	-,192	,198		-,973	,359		
	Action Comprehension	1,03	,054	,989	19	,000	1,000	1,000

**Dependent variable: Action imagination observation*

QUESTIONNAIRES

Nombre y apellidos:			
Nº	Sexo: VARÓN MUJER	Edad:	Fecha de hoy: / /
Procedencia:		Entrevistador:	

SCL-90-R

Cuestionario de 90 síntomas

El presente cuestionario forma parte de su historia clínica y está sujeto a estricto secreto profesional

INSTRUCCIONES

Lea atentamente la lista que presentamos en las páginas siguientes. Son problemas y molestias que casi todo el mundo sufre alguna vez. Piense si a usted le ha pasado en las últimas semanas, incluyendo el día de hoy.

Rodee con un círculo el **cero** (0) si no ha tenido esa molestia en absoluto; el **uno** (1) si la ha tenido un poco presente; el **dos** (2) si la ha tenido moderadamente; el **tres** (3) si la ha tenido bastante y el **cuatro** (4) si la ha tenido mucho o extremadamente.

HASTA QUÉ PUNTO SE HA SENTIDO MOLESTO POR EL SÍNTOMA

0	1	2	3	4
Nada en absoluto	Un poco	Moderadamente	Bastante	Mucho o extremadamente

RODEE CON UN CÍRCULO LA ALTERNATIVA ELEGIDA

1	Dolores de cabeza	0	1	2	3	4
2	Nerviosismo o agitación interior	0	1	2	3	4
3	Pensamientos, palabras o ideas no deseadas que no se van de su mente	0	1	2	3	4
4	Sensaciones de desmayo o mareo	0	1	2	3	4
5	Pérdida de deseo o de placer sexual	0	1	2	3	4
6	Ver a la gente de manera negativa, encontrar siempre faltas	0	1	2	3	4
7	La idea de que otra persona pueda controlar sus pensamientos	0	1	2	3	4
8	La impresión de que la mayoría de sus problemas son culpa de los demás	0	1	2	3	4
9	La dificultad para recordar las cosas	0	1	2	3	4
10	Preocupación acerca del desaseo, el descuido o la desorganización	0	1	2	3	4
11	Sentirse fácilmente molesto, irritado o enfadado	0	1	2	3	4
12	Dolores en el corazón o en el pecho	0	1	2	3	4
13	Sentir miedo de los espacios abiertos o en la calle	0	1	2	3	4
14	Sentirse bajo de energías o decaído	0	1	2	3	4
15	Pensamientos suicidas, o ideas de acabar con su vida	0	1	2	3	4
16	Oír voces que otras personas no oyen	0	1	2	3	4
17	Temblores	0	1	2	3	4
18	La idea de que uno no se puede fiar de la gente	0	1	2	3	4
19	Falta de apetito	0	1	2	3	4
20	Llorar fácilmente	0	1	2	3	4
21	Timidez o incomodidad ante el sexo opuesto.	0	1	2	3	4
22	La sensación de estar atrapado o como encerrado	0	1	2	3	4
23	Tener miedo de repente y sin razón	0	1	2	3	4
24	Arrebatos de cólera o ataques de furia que no logra controlar	0	1	2	3	4
25	Miedo a salir de casa solo	0	1	2	3	4
26	Culparse a sí mismo de todo lo que pasa	0	1	2	3	4
27	Dolores en la parte baja de la espalda	0	1	2	3	4
28	Sentirse incapaz de hacer las cosas o terminar las tareas.	0	1	2	3	4
29	Sentirse solo	0	1	2	3	4
30	Sentirse triste	0	1	2	3	4
31	Preocuparse demasiado por todo	0	1	2	3	4
32	No sentir interés por nada	0	1	2	3	4
33	Sentirse temeroso	0	1	2	3	4
34	Ser demasiado sensible o sentirse herido con facilidad	0	1	2	3	4
35	La impresión de que los demás se dan cuenta de lo que está pensando	0	1	2	3	4
36	La sensación de que los demás no le comprenden o no le hacen caso	0	1	2	3	4
37	La impresión de que otras personas son poco amistosas o que usted no les gusta	0	1	2	3	4
38	Tener que hacer las cosas muy despacio para estar seguro de que las hace bien .	0	1	2	3	4
39	Que su corazón palpite o vaya muy deprisa..	0	1	2	3	4
40	Náuseas o malestar en el estómago	0	1	2	3	4
41	Sentirse inferior a los demás	0	1	2	3	4
42	Dolores musculares	0	1	2	3	4
43	Sensación de que las otras personas le miran o hablan de usted	0	1	2	3	4
44	Dificultad para conciliar el sueño	0	1	2	3	4
45	Tener que comprobar una y otra vez todo lo que hace	0	1	2	3	4

NO SE DETENGA, CONTINÚE EN LA PÁGINA SIGUIENTE

RODEE CON UN CÍRCULO LA ALTERNATIVA ELEGIDA

46	Dificultad en tomar decisiones	0	1	2	3	4
47	Sentir temor de viajar en coche, autobuses, metros o trenes	0	1	2	3	4
48	Ahogos o dificultad para respirar	0	1	2	3	4
49	Escalofríos, sentir calor o frío de repente	0	1	2	3	4
50	Tener que evitar ciertas cosas, lugares o actividades porque le dan miedo	0	1	2	3	4
51	Que se le quede la mente en blanco	0	1	2	3	4
52	Entumecimiento u hormigueo en alguna parte del cuerpo	0	1	2	3	4
53	Sentir un nudo en la garganta	0	1	2	3	4
54	Sentirse desesperanzado con respecto al futuro	0	1	2	3	4
55	Tener dificultades para concentrarse	0	1	2	3	4
56	Sentirse débil en alguna parte del cuerpo	0	1	2	3	4
57	Sentirse tenso o con los nervios de punta	0	1	2	3	4
58	Pesadez en los brazos o en las piernas	0	1	2	3	4
59	Ideas sobre la muerte o el hecho de morir	0	1	2	3	4
60	El comer demasiado	0	1	2	3	4
61	Sentirse incómodo cuando la gente le mira o habla acerca de usted	0	1	2	3	4
62	Tener pensamientos que no son suyos	0	1	2	3	4
63	Sentir el impulso de pegar, golpear o hacer daño a alguien	0	1	2	3	4
64	Despertarse de madrugada	0	1	2	3	4
65	Impulsos a tener que hacer las cosas de manera repetida (tocar algo, lavarse…)	0	1	2	3	4
66	Sueño inquieto o perturbado	0	1	2	3	4
67	Tener ganas de romper o estrellar algo	0	1	2	3	4
68	Tener ideas o creencias que los demás no comparten	0	1	2	3	4
69	Sentirse muy cohibido o vergonzoso entre otras personas	0	1	2	3	4
70	Sentirse incómodo entre mucha gente, por ejemplo en el cine, tiendas, etc.	0	1	2	3	4
71	Sentir que todo requiere un gran esfuerzo..	0	1	2	3	4
72	Ataques de terror o pánico	0	1	2	3	4
73	Sentirse incómodo comiendo o bebiendo en público	0	1	2	3	4
74	Tener discusiones frecuentes	0	1	2	3	4
75	Sentirse nervioso cuando se queda solo	0	1	2	3	4
76	El que otros no le reconozcan adecuadamente sus méritos	0	1	2	3	4
77	Sentirse solo aunque esté con más gente	0	1	2	3	4
78	Sentirse tan inquieto que no puede ni estar sentado tranquilo	0	1	2	3	4
79	La sensación de ser inútil o no valer nada.	0	1	2	3	4
80	Presentimientos de que va a pasar algo malo	0	1	2	3	4
81	Gritar o tirar cosas	0	1	2	3	4
82	Tener miedo de desmayarse en público	0	1	2	3	4
83	La impresión de que la gente intentaría aprovecharse de ud. si se lo permitiera .	0	1	2	3	4
84	Tener pensamientos sobre el sexo que le inquietan bastante	0	1	2	3	4
85	La idea de que debería ser castigado por sus pecados o sus errores	0	1	2	3	4
86	Pensamientos o imágenes estremecedoras o que le dan miedo	0	1	2	3	4
87	La idea de que algo serio anda mal en su cuerpo	0	1	2	3	4
88	Sentirse siempre distante, sin sensación de intimidad con nadie	0	1	2	3	4
89	Sentimientos de culpabilidad	0	1	2	3	4
90	La idea de que algo anda mal en su mente	0	1	2	3	4

FIN DE LA PRUEBA. COMPRUEBE QUE HA VALORADO TODAS LAS FRASES.

MUY IMPORTANTE

NO ESCRIBA NADA EN ESTE RECUADRO O PODRÍA INVALIDAR SU EJERCICIO.

- TRASLADE LAS PUNTUACIONES DE CADA FILA A SU RECUADRO CORRESPONDIENTE.
- LUEGO SUME LAS PUNTUACIONES DE CADA COLUMNA PARA OBTENER LA PUNTUACIÓN DE CADA ESCALA.
- SUME TAMBIÉN LAS PUNTUACIONES DE LOS ÍTEMS ADICIONALES Y TRASLADE LA SUMA AL CUADRO CORRESPONDIENTE.
- FINALMENTE REALICE LAS OPERACIONES INDICADAS PARA OBTENER EL TOTAL Y LOS ÍNDICES GENERALES.

	SOM	OBS	INT	DEP	ANS	HOS	FOB	PAR	PSI					
1	□									0	1	2	3	4
2					□					0	1	2	3	4
3		□								0	1	2	3	4
4	□									0	1	2	3	4
5				□						0	1	2	3	4
6			□							0	1	2	3	4
7									□	0	1	2	3	4
8								□		0	1	2	3	4
9		□								0	1	2	3	4
10		□								0	1	2	3	4
11						□				0	1	2	3	4
12	□									0	1	2	3	4
13							□			0	1	2	3	4
14				□						0	1	2	3	4
15				□						0	1	2	3	4
16									□	0	1	2	3	4
17					□					0	1	2	3	4
18								□		0	1	2	3	4
19	ÍTEM ADICIONAL									0	1	2	3	4
20				□						0	1	2	3	4
21			□							0	1	2	3	4
22				□						0	1	2	3	4
23					□					0	1	2	3	4
24						□				0	1	2	3	4
25							□			0	1	2	3	4
26				□						0	1	2	3	4
27	□									0	1	2	3	4
28		□								0	1	2	3	4
29				□						0	1	2	3	4
30				□						0	1	2	3	4
31				□						0	1	2	3	4
32				□						0	1	2	3	4
33					□					0	1	2	3	4
34			□							0	1	2	3	4
35									□	0	1	2	3	4
36			□							0	1	2	3	4
37			□							0	1	2	3	4
38		□								0	1	2	3	4
39					□					0	1	2	3	4
40	□									0	1	2	3	4
41			□							0	1	2	3	4
42	□									0	1	2	3	4
43								□		0	1	2	3	4
44	ÍTEM ADICIONAL									0	1	2	3	4
45		□								0	1	2	3	4

CONTINÚE LAS SUMAS CON LAS COLUMNAS DE LA PÁGINA SIGUIENTE

	SOM	OBS	INT	DEP	ANS	HOS	FOB	PAR	PSI					
46		☐								0	1	2	3	4
47							☐			0	1	2	3	4
48	☐									0	1	2	3	4
49	☐									0	1	2	3	4
50							☐			0	1	2	3	4
51		☐								0	1	2	3	4
52	☐									0	1	2	3	4
53	☐									0	1	2	3	4
54				☐						0	1	2	3	4
55		☐								0	1	2	3	4
56	☐									0	1	2	3	4
57					☐					0	1	2	3	4
58	☐									0	1	2	3	4
59	ÍTEM ADICIONAL									0	1	2	3	4
60	ÍTEM ADICIONAL									0	1	2	3	4
61			☐							0	1	2	3	4
62									☐	0	1	2	3	4
63						☐				0	1	2	3	4
64	ÍTEM ADICIONAL									0	1	2	3	4
65		☐								0	1	2	3	4
66	ÍTEM ADICIONAL									0	1	2	3	4
67						☐				0	1	2	3	4
68								☐		0	1	2	3	4
69			☐							0	1	2	3	4
70							☐			0	1	2	3	4
71				☐						0	1	2	3	4
72					☐					0	1	2	3	4
73			☐							0	1	2	3	4
74						☐				0	1	2	3	4
75							☐			0	1	2	3	4
76								☐		0	1	2	3	4
77									☐	0	1	2	3	4
78					☐					0	1	2	3	4
79				☐						0	1	2	3	4
80					☐					0	1	2	3	4
81						☐				0	1	2	3	4
82							☐			0	1	2	3	4
83								☐		0	1	2	3	4
84									☐	0	1	2	3	4
85									☐	0	1	2	3	4
86					☐					0	1	2	3	4
87									☐	0	1	2	3	4
88									☐	0	1	2	3	4
89	ÍTEM ADICIONAL									0	1	2	3	4
90									☐	0	1	2	3	4

TOTAL ☐ + ☐ + ☐ + ☐ + ☐ + ☐ + ☐ + ☐ + ☐ + ☐ = ☐ / Nº ítems = ☐

	SOM	OBS	INT	DEP	ANS	HOS	FOB	PAR	PSI	ÍTEM ADICIONAL	TOTAL	GSI
	12	10	9	13	10	6	7	6	10	7		
PD	☐	☐	☐	☐	☐	☐	☐	☐	☐			

PST ☐ (Total respuestas positivas) GSI ☐ x 90 / PST ☐ = PSDI ☐ → Convertir a puntuaciones T ☐

Perfil

- Traslade las puntuaciones directas (PD) de la fila que se encuentra en la base al dorso de esta página a la fila PD de ésta.
- Consulte el baremo que haya decidido emplear y trace las líneas del perfil.

Baremo utilizado:

PD													PD
PC	SOM	OBS	INT	DEP	ANS	HOS	FOB	PAR	PSI	GSI	PST	PSDI	T
99													75
97													70
95													67
90													63
85													60
80													58
75													57
70													55
65													54
60													53
55													51
50													50
45													49
40													47
35													46
30													45
25													43
20													42
15													40
10													37
5													34
PC	SOM	OBS	INT	DEP	ANS	HOS	FOB	PAR	PSI	GSI	PST	PSDI	T

EDINBURGH HANDEDNESS INVENTORY

(Oldfield, 1971; Bryden, 1977)

Nombre: Varón [ ] Mujer [ ]
Fecha: F. nacimiento: Edad:
Estudios/Profesión: Observaciones:

INSTRUCCIONES: *Marque la casilla correspondiente con*

+ *una cruz, si es la mano que utiliza de modo preferente.*

++ *dos cruces, si es la mano que utiliza de modo muy preferente y además le resultaría imposible o muy difícil hacerlo con la otra mano.*

+ *una cruz, en las dos casillas cuando pueda hacerlo tan bien tanto con una mano como con la otra.*

¿QUÉ MANO UTILIZA PARA?	**DERECHA**	**IZQUIERDA**	**Puntos**
1. Escribir			**1-2-3-4-5**
2. Dibujar			**1-2-3-4-5**
3. Lanzar un objeto			**1-2-3-4-5**
4. Limpiarse los dientes			**1-2-3-4-5**
5. Utilizar un cuchillo (sin tenedor)			**1-2-3-4-5**
6. Cortar con tijeras			**1-2-3-4-5**
7. Comer con la cuchara			**1-2-3-4-5**
8. La mano que coloca en la parte superior de la escoba para barrer			**1-2-3-4-5**
9. Rascar una cerilla			**1-2-3-4-5**
10. Levantar la tapa de una caja			**1-2-3-4-5**

Puntos:
5 si ++ sólo en mano izquierda
4 si + sólo en mano izquierda
3 si + en manos izquierda y derecha
2 si + sólo en mano derecha
1 si ++ sólo en mano derecha

Consistentemente zurdo/a: 50 ptos (Máximo)
Consistententemente diestro/a: 10 ptos (Mínimo)

Cuestionario de experiencia en danza

Práctica de Ballet

1. ¿Normalmente bailas ballet?

Sí/No

2. ¿Cuánto tiempo llevas bailando ballet?

Especificar en años, meses, semanas

3. ¿Cuántas horas a la semana practicas ballet?

Especificar en horas

4. ¿Cuántas horas al mes practicas ballet?

Especificar en horas

5. ¿Has recibido clases formales de ballet?

Sí/No

6. ¿Por cuánto tiempo has recibido clases formales de ballet?

Especificar en años, meses, semanas

7. ¿Qué tipo de ballet practicas?

Ballet clásico/Ballet Moderno/Ballet cortesano/Otro

Práctica de danza

8. ¿Practicas otros tipos de danzas?

Sí/No

9. ¿Has recibido clases formales de este otro tipo de danza?

Sí/No

10. ¿Por cuánto tiempo has recibido clases formales de este otro tipo de danza?

Especificar en años, meses, semanas.

11. ¿Bailas por diversión (fiestas, discotecas, etc)?

Sí/No

12. ¿Cuántas horas a la semana bailas por diversión?

Especificar en horas

Enseñanza de ballet

13. ¿Enseñas a otras personas a bailar ballet?

Sí/No

14. ¿Cuántas horas a la semana enseñas ballet?

Especificar en horas

15. ¿Tus principales ingresos económicos provienen de la enseñanza de ballet?

Sí/No

16. ¿Te consideras a ti misma una bailarina de ballet profesional?

Sí/No

17. ¿Te consideras a ti misma como bailarina…?

a) Novata b) Principiante c) Intermedia d) Experta

Familiaridad con los videos observados

18. ¿Qué nivel de familiaridad tienes con los pasos de ballet observados previamente en los vídeos?

a) Ninguno b) Sabía 1 o 2 pasos de baile c) Sabía la mitad de los pasos de baile d) Sabía la mayoría de los pasos de baile e) Sabía todos los pasos de baile

19. ¿Con cuánta frecuencia has realizado los movimientos previamente observados en los vídeos?

a) Nunca b) Algunas veces al año c) Algunas veces al mes d) Algunas veces a la semana e) Cada día

20. ¿Cuánto conoces el Ballet clásico?

a) En absoluto b) Muy poco c) Moderadamente d) Bastante bien e) Perfectamente bien

21. ¿En qué grado te has imaginado a ti misma realizando los movimientos observados mientras mirabas estos vídeos?

a) Nada b) En un movimiento c) En más de un movimiento d) En casi todos los movimientos e) En todos los movimientos observados

Facultat d'Educació i Psicologia
Treball de Final de Grau

Nº **ID** ____________

CONSENTIMIENTO INFORMADO EN PRUEBAS CONDUCTUALES DE LABORATORIO

Título del estudio: *Influence of motor expertise in the mirror neuron System activation: non-expert versus expert ballet dancers.*
Población de estudio: *voluntarios sanos*
Estudiante responsable: Kenia Arteaga Fuentes/ 688478500/ u1953212@campus.udg.edu

El presente informe tiene como objetivo primordial proporcionarle toda la información necesaria para que pueda decidir libre y voluntariamente si quiere participar en este estudio. Para ello, debe leer atentamente la siguiente información y preguntar cualquier duda al respecto.

PROPÓSITO DEL ESTUDIO
El objetivo del presente estudio es investigar en sujetos sanos, la relación entre el nivel de experteza motora, en la activación del sistema neuronal denominado sistema de neuronas espejo. Aproximadamente 10 personas participarán en este estudio.

PROCEDIMIENTO
El presente estudio consta de dos sesiones: la primera con la realización de una prueba de evaluación psicológica rápida con la que se obtiene un resultado del nivel de malestar general. Una segunda sesión de 20 minutos, dividida en dos partes. Una primera evaluación mediante el registro de la mirada a través de un aparato llamado Eye Tracker, en el que se observarán durante 4 minutos clips 1minuto aproximadamente sobre danza y sobre movimientos de la vida cotidiana. La segunda parte consiste en el registro de sus respuestas durante la administración una prueba computerizada.

Por la participación en el estudio recibirá un obsequio previamente acordado con la experimentadora.

RIESGOS E INCOMODIDADES
El riesgo personal por participar en este proyecto no supera los riesgos normales y corrientes de la vida. Ninguno de los procedimientos representa peligro alguno para la salud o integridad física.

BENEFICIOS
Este estudio puede que directamente no le produzca ningún beneficio. Cómo beneficio inmediato, se le proporcionará el resultado de la prueba de evaluacion psicológica, al mismo tiempo por la participación obtendrá un obsequio previamente acordado.

Los siguientes párrafos contienen información que normalmente se aplica a las personas que participan en investigaciones y a las que se les pregunta por su consentimiento informado.

CONFIDENCIALIDAD

La estudiante responsable grabará la información en un archivo y será identificado solamente mediante un código y numero de identificación. El código del estudio está formado por unas letras o dígitos a los que se añade después un número asignado por el investigador (ej., **KAF0**) El número de identificación que se conecta con su nombre se mantendrá almacenado en un archivo aparte y de manera segura. La información que contienen sus registros no se proporcionará a nadie y se protegerá la privacidad de sus datos. Los resultados de este estudio se usaran únicamente con finalidades académicas. Sin embargo su nombre u otros posibles identificadores no se utilizarán en ningún documento.

DERECHO A TENER MÁS INFORMACIÓN SOBRE EL ESTUDIO

Usted puede hacer cualquier pregunta acerca del estudio siempre que quiera a lo largo del registro. El estudiante responsable (véase primera página) estará disponible para poder responder a sus preguntas, intereses o preocupaciones acerca del estudio.

RECHAZO O ABANDONO DE LA PARTICIPACIÓN

La participación en este estudio es voluntaria. No tiene que participar en el estudio si no quiere. Si decide participar, usted puede cambiar de parecer o dejar el estudio en cualquier momento sin que por ello se vea afectado en ninguna medida.

FIRMA

Yo afirmo que se me ha explicado la finalidad y objetivos de la presente investigación, los procedimientos utilizados en el estudio, los posibles riegos e incomodidades, así como los derechos y beneficios potenciales que pueda experimentar a lo largo del mismo. Las alternativas posibles a la participación del estudio también han sido discutidas, entre ellas la posibilidad de retirarme del estudio cuando quiera y sin tener que dar explicaciones. Me han respondido también a las distintas preguntas que he formulado. Declaro que he leído este consentimiento informado y que la firma a continuación expresa mi deseo de participar voluntariamente en este estudio.

____ __________________

Voluntario Fecha

El abajo firmante declara haber explicado la finalidad de la investigación, los procedimientos utilizados en el estudio, identificando aquellos que tienen finalidad meramente de investigación, los posibles riesgos e incomodidades que puedan originarse y he respondido lo mejor que he podido a las preguntas que se me han formulado con respecto al estudio.

____ __________________

Estudiante responsable del estudio Fecha