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Can Constructive Thinking Predict Decision Making?

ANA SANTOS-RUIZ[1]*, MARIA JOSE FERNANDEZ-SERRANO[2], HUMBELINA ROBLES-ORTEGA[1], MIGUEL PEREZ-GARCIA[1], NURIA NAVARRETE-NAVARRETE[3] and MARIA ISABEL PERALTA-RAMIREZ[1]

[1] *Department of Clinical Psychology, University of Granada, Spain*
[2] *Department of Psychology, University of Jaen, Spain*
[3] *University Hospital "Virgen de las Nieves", Granada, Spain*

ABSTRACT

We assume that executive function constitutes an integrated set of cognitive processes that mediate working memory, planning, inhibition, flexibility, and decision making. Despite the acknowledged theoretical connection between executive function processes and emotional intelligence, such relationships have rarely been investigated. The purpose of this study was to examine the potential relationship between constructive thinking, conceived as a component of emotional intelligence, and executive function, as indexed by various existing neuropsychological and experimental instruments. We used the *Constructive Thinking Inventory* as a measure of emotional intelligence. We found that some constructive thinking subscales were able to predict distinct executive function variables. Emotional Coping, Categorical Thinking, and Esoteric Thinking subscales explained performance on various measures of executive function. Thus, we conclude that intervention programs designed to train a specific component of emotional intelligence, namely constructive thinking, could also facilitate performance in executive function processes, and vice versa. Copyright © 2011 John Wiley & Sons, Ltd.

KEY WORDS constructive thinking; executive function; dorsolateral prefontal cortex; ventromedial prefontal cortex

INTRODUCTION

Over the last few decades, neuropsychology has paid special attention to the study of executive function. And yet, despite the widespread use of the term "executive function" in neuropsychological research, the persistent lack of agreement about its definition and dimensions continues to generate a great deal of controversy (Jurado & Rosselli, 2007).

Some authors consider executive function to be a unitary concept or a central factor (e.g., general intelligence or working memory), which underlies executive function and is responsible for the organization of goal-directed behavior (De Frias, Dixon, & Strauss, 2006; Duncan, Emslie, Williams, Johnson, & Freer, 1996; Kimberg, D'Esposito, & Farah, 1997; Parkin & Java, 1999). In contrast, some researchers define executive function as a multiple processing system that combines a set of skills involved in the production, supervision, and control of goal-directed behaviors (Baddeley, 1998; Roberts, Robbins, & Weiskrantz, 1998; Stuss & Knight, 2002) and in the regulation of emotional states considered adaptive for the execution of such behaviors (Bechara, Damasio, & Damasio, 2000a; Davidson, 2002; Stuss & Alexander, 2000). In clear contradiction to the unitary factor theory are those studies of patients with frontal lobe lesions, which indicate that there is a division of executive functions related to the functional division of the frontal lobes (Godefroy, Cabaret, Petit-Chenal, Pruvo, & Rousseaux, 1999; Stuss & Knight, 2002). In this study, we endorse the second view of executive function and assume that it constitutes an integrated set of processes that mediate working memory, planning, inhibition, flexibility, and decision making (Verdejo-Garcia & Perez-Garcia, 2007).

Various studies have distinguished the neuroanatomical correlates of distinct executive function processes (Roberts et al., 1998; Tekin & Cummings, 2002). Thus, the dorsolateral prefrontal cortex has been associated with planning, goal selection, shifting, and self-monitoring functions (Royall et al., 2002), that is, operations that could be considered "metacognitive" in nature (Ardila & Ostroksy-Solís, 2008). The ventromedial prefrontal cortex, on the contrary, has been related to the expression and control of emotional and instinctive behaviors (Fuster, 1997, 2002) and to decision making (Bechara, 2004; Bechara, Damasio, Damasio, & Lee, 1999; Bechara, Damasio, Tranel, & Anderson, 1998; Bechara et al., 2000a) and, together with the emotional processes associated with the limbic system (at the subcortical level), has been considered the equivalent of "emotional executive functions" (Ardila & Ostroksy-Solís, 2008). For these reasons, it has been suggested that the prefrontal cortex may constitute the center for the integration of emotion and cognition (Mitchell & Phillips, 2007).

According to Somatic Marker Hypothesis (SMH) by Damasio (1994), the decision-making process is a clear example of the connection between cognition and emotion. Decision making has been defined as the ability to select the course of action that is most adaptive for the organism among a group of possible alternative behaviors (Bechara et al., 2000a). According to the SMH, decision making is a process that depends on emotional signals, defined as bio-regulatory responses destined to maintain homeostasis and ensure survival (Damasio, 1994). This hypothesis is supported by those deficits in performance observed in patients with damage to the ventromedial prefrontal cortex on the Iowa Gambling Task (IGT). Decision making has also been studied by Shallice and

*Correspondence to: Ana Santos-Ruiz, Department of Clinical Psychology, Faculty of Psychology, University of Granada, Campus de Cartuja s/n. 18071, Granada, Spain. E-mail: anamsantos@ugr.es

Burgess (1991), who proposed a model in which decision making is mediated by "intentional markers," rather than emotional signals, and in which deficits in strategy application are associated with failures of the cognitive control systems. Both models given by Damasio (1994) and Shallice and Burgess (1991) support the existence of "markers" whose function is to guide the individual to obtain the best final result. The main difference between them stems from the SMH linking these markers to systems related with viscera and the periphery, and the model by Shallice and Burgess placing these markers at the cognitive level. Notwithstanding this difference, Burgess, Veitch, Lacy Costello, and Shallice (2000) argue that there is no contradiction between the models, as they both aim to explain different aspects of executive dysfunction observed in patients with ventromedial prefrontal damage.

Some researchers have associated the SMH with the concept of emotional intelligence because in emotional intelligence, like in the SMH, emotions are assigned the role of guiding human behavior (Bechara, Tranel, & Damasio, 2000b). Emotional intelligence is a predictive characteristic of many of the key skills and adaptive responses required for success in life. Reuven Bar-On (2000, 2001) is one of the main supporters of the relationship between the SMH and emotional intelligence. He proposed a conceptual link between them and defined emotional intelligence as "a multi-factorial array of interrelated social, personal and emotional skills that influence our ability to actively and effectively cope with the demands of daily living". As for the assessment of emotional intelligence factors, Epstein and Meier (1989), on the basis of the cognitive-experiential self-theory (Epstein, 1990), proposed the concept of "constructive thinking" as a measure of practical and emotional intelligence, opposite to rational intelligence. These authors conceptualize constructive thinking as "the habitual thought processes that help a person construe and respond to events adaptively and with minimal stress". According to Epstein (1998), examples of good constructive thinking would be viewing situations as challenges rather than threats, considering failures and rejections as unfortunate but not the end of the world, and seeing the positive side of things but not to an unrealistic degree. In contrast, examples of poor constructive thinking would be dwelling on negative events, thinking in extremely categorical ways, overgeneralizing, worrying needlessly, and thinking in ways that increase unhappiness without accomplishing anything worthwhile.

To date, numerous studies have focused on examining executive function, especially decision making (Bechara et al., 1998; Bechara et al., 1999; Bechara et al., 2000a; Damasio, 1994; Damasio, 1996; Damasio, Tranel, & Damasio, 1991; Verdejo-Garcia & Perez-Garcia, 2007; Zermatten, Van der Linden, d'Acremont, Jermann, & Bechara, 2005). Similarly, the concept of constructive thinking has attracted much interest in the laboratory (Epstein, 1993; Epstein & Meier, 1989; Epstein & Katz, 1992; Katz & Epstein, 1991; Killgore et al., 2008; Park, Moore, Turner, & Adler, 1997; Scheurer & Epstein, 1997). And yet very few studies have focused on demonstrating the possible association between these two concepts. Specifically, Giancola, Schoal, and Mezzich (2001) observed poor executive functioning and poor constructive thinking in female adolescents with drug use disorder and related antisocial behavior. Their results could be explained by the fact that the inability to face difficult situations in everyday life may lead to the development of antisocial behavior and related drug use as a maladaptive strategy.

As for the relation between constructive thinking and decision making, they both aim to adaptively solve problematic situations in everyday life. Moreover, we consider that during the decision-making process under conditions of uncertainty, the individual is influenced not only by the activation of somatic markers but also by his or her constructive thinking ability, related in turn to their emotional intelligence. This includes the way of thinking, feeling, and acting of each individual, which will positively or negatively influence the decision-making process.

The relationship between constructive thinking and the decision-making process would lead to the hypothesis that individuals with poor constructive thinking abilities should make deficient decisions in their daily lives, and vice versa. In line with this hypothesis, the purpose of this study was to examine the potential relationship between constructive thinking skills and executive function, as indexed by various existing neuropsychological and experimental instruments.

METHOD

Participants

Fifty-eight healthy adults (36 women) participated in this study. Their mean age was 42 years (SD = 11.92), and they had 15 years of education (SD = 3.26) on average. They were recruited in Córdoba and Granada, two cities in southern Spain, from among the teaching and research staff of the University of Granada. They were initially contacted by email and informed of the nature of the study, after which they were asked to provide informed consent for their participation. Subjects who were between 18 and 65 years of age; free from substance abuse disorders, neurological damage, and psychiatric pathology; and whose scores on the SCL-90 Symptoms Inventory (Derogatis, 1994) were less than two standard deviations from the mean were admitted into the study. Five of the original 58 subjects (3 men and 2 women) were not included in the final statistical analysis, as their scores on the *SCL-90-R Symptoms Inventory* (Derogatis, 1994) were more than two standard deviations below the mean.

Instruments

SCL-90-R Symptoms Inventory

(Derogatis, 1994): We used this instrument to rule out possible psychopathology in the participants. This self-report questionnaire was developed to assess symptoms of psychopathology in individuals. It includes 90 items with five response alternatives (0–4) in a Likert scale. Subjects must respond according to how they have felt within the past 7 days, including the day the inventory is administered. The inventory is scored and interpreted according to nine main dimensions (somatization, obsessive-compulsive symptoms, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism) and

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three global indices of psychological distress (Global Severity Index, Positive Symptom Total, and Positive Symptom Distress Index).

The Constructive Thinking Inventory
(Epstein, 2001) is a 108-item self-report inventory that includes a global scale of constructive versus destructive automatic thinking and six factor scales:

Global Constructive Thinking. This bipolar scale measures a general tendency to automatically think in constructive or destructive ways.

Emotional Coping. This bipolar scale refers to the tendency to cope with potentially stressful situations in adaptive or maladaptive ways. Individuals with a higher score are able to face potentially stressful situations like a challenge rather than with fear, thus suffering less stress than others.

Behavioral Coping. This bipolar scale measures the tendency to automatically think in terms that facilitate effective action.

Categorical Thinking. A high score on this scale indicates dichotomous thought that tends to categorize, simplify, and be prejudiced; however, this inherent rigidity facilitates action and quick decisions.

Personal Superstitious Thinking. This scale measures the extent to which people cling to private superstitions to defend themselves from threats rather than achieve happiness and perfection. It is directly related to pessimism.

Esoteric Thinking. This scale indicates the degree to which people believe in strange, magical, and scientifically questionable phenomena (e.g., ghosts).

Naive Optimism. This scale reflects the degree to which a person is optimistic for no apparent reason.

This instrument is highly reliable following test-retest and two-half procedures (Epstein, 2001).

Measures of Executive Function
Executive function tests were classified in two groups according to their putative neuroanatomical substrates: tests mediated by the dorsolateral prefrontal cortex (DLPC) and tests mediated by the ventromedial prefrontal cortex (VMPC).

Tests mediated by the DLPC (Royall et al., 2002).

Trail Making Test (Horton, 1979). This test contains two parts: A and B. Part A consists of 25 consecutive numbers, each of which has a circle around it. The subject has to connect them in increasing order, drawing a line between each of the elements in the series. Part B is more complex, as the participant must draw a line alternating between numbers and letters. Both parts must be done as quickly as possible. The Trail Making Test provides measures of number and letter recognition, visual detection, cognitive flexibility, speed of processing, working memory, and motor and sequential skills (Horton, 1979).

Letters and numbers subtest of the Wechsler Adult Intelligence Scale III. (WAIS-III; Wechsler, 1997). This test measures working memory. A combined sequence of letters and numbers is read aloud to the participant, who must reproduce it, placing the numbers first in ascending order and then the letters in alphabetical order.

Five digit test (Sedó, 2005). This test comprises four parts that are administered separately and consist of a series of 50 boxes, each of which contains one to five digits (parts 1, 3, and 4) or stars (part 2), organized in patterns similar to those on domino pieces or playing cards. In part 1 (reading), the participant must read the digits as fast as possible; and in part 2 (counting), the participant must count the number of stars in each box. In part 3 (interference), the participant has to count the number of digits in each box, while inhibiting the automatic response of naming the digits in each of the boxes. Finally, in part 4 (shifting), the task involves counting or reading, depending on whether the box's outline is thin (counting, 80% of the stimuli) or thick (reading, 20%). Parts 1 and 2 (reading and counting) are basic attention and speed of processing measures. In contrast, parts 3 and 4 (interference and shifting) are sensitive to the functioning of complex executive processes, such as selective attention and automatic response suppression. In this test, the main dependent variables are the difference in performance time between part 3 and the mean of parts 1 and 2 (differential "interference" performance), and the difference in performance time between part 4 and the means of parts 1 and 2 (differential "shifting" performance).

Zoo map test (Wilson, Alderman, Burgess, Emslie, & Evans, 1996). This is a subtest of the Behavioral Assessment of the Dysexecutive Syndrome neuropsychological battery, and it explicitly measures planning. Participants are presented with the map of a zoo together with some instructions regarding the places they must visit, while observing a series of rules. They must plan a route to visit the designated places, trying to make the fewest possible errors. The dependent variable on this test is the difference between the places visited correctly and the procedural errors (i.e., using unshaded paths more than once, going off the path, not drawing continuous lines, or visiting places that were not indicated).

Revised Strategy Application Test (R-SAT). We used a version of the instrument of Levine, Dawson, Boutet, Schwartz, and Stuss (2000), adapted by Verdejo-Garcia, Rivas-Perez, Vilar-López, and Pérez-García (2007). The R-SAT is a multitasking test that was first proposed by Shallice and Burgess (1991). The R-SAT evaluates self-regulation, planning, decision making, and reversal learning in conditions of ambiguity and uncertainty similar to those found in real-life situations. Also, performance on this test seems to be dependent on the integrity of the right dorsolateral prefrontal cortex and the posterior cingulate cortex (Burgess et al., 2000; Verdejo-Garcia & Bechara, 2010). Therefore, it is considered an ecological measure. The test consists of three simple tasks: drawing figures, copying sentences, and counting

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objects. Each task is presented in two different piles (A and B) with 10 sheets each. Every sheet contains 12 elements. The objective of the test is to obtain the highest possible number of points, taking into account that each of the brief elements completed will be rewarded with 100 points, whereas the large elements will be worth zero points. The participants must perform all three tasks within 10 minutes and to finish the test they have to complete a minimum of 50 elements, excluding those presented on the first page of each task. The most adaptive strategy is to focus exclusively on the brief items. This implicit strategy constitutes the main index of performance on the task, measured as the proportion of brief elements completed with respect to the total number of elements completed (*R-SAT brief items*). Another dependent variable is the number of errors or action-slips made by the participants, defined as the number of irrelevant elements totally or partially completed (*R-SAT action-slips*). This measure is an index of the subjects' impulsivity or, conversely, their capacity for response inhibition.

Tests mediated by the VMPC.

The Iowa Gambling Task. (Bechara, Damasio, Damasio, & Anderson, 1994) has been used to assess decision making in a wide array of studies (Bechara, 2004). It has been established that performance on this task involves a neural circuit including the orbitofrontal/ventromedial prefrontal cortex, amygdala, and posterior cingulate cortex.

The computerized version of the IGT simulates the essential components of everyday decisions and the evaluation of rewarding events and punishments in uncertain and risky conditions. In the task, subjects must choose between four decks of cards. Unbeknown to them, two of the decks provide high immediate winnings but a greater future loss (long-term loss), whereas the other two decks provide lower immediate winnings but less of a future loss (long-term gains). Participants receive messages (feedback) about the consequences of each choice they make. The objective of the task is to win as much money as possible and, if winning is not possible, to try not to lose. Therefore, to earn money on the task, the appropriate strategy is to consistently choose cards from the decks associated with long-term gains (i.e., advantageous) and ignore the decks that provide immediate winnings and long-term losses (i.e., disadvantageous). The main dependent variable is the difference between the number of advantageous and disadvantageous choices in each of the five blocks of 20 trials.

Procedure

Subjects participated voluntarily in this study, completing the assessment sessions individually and within a flexible timetable. Participants received information about the objectives of the study and signed informed consents before proceeding to the first session. In it, they were interviewed and provided sociodemographic data, including age and years of education. Subsequently, we administered the SCL-90 Symptom Checklist and Constructive Thinking Inventory self-reports. Finally, an experienced neuropsychologist administered the battery of neuropsychological tests specified above, which was explicitly selected for the assessment of executive function. This session lasted approximately one and a half hours.

Statistical analysis

To test which constructive thinking variables best explain scores obtained on executive function tasks, we performed multiple regression analyses using the stepwise method. Dependent measures were the scores on each of the subscales of the two types of executive function tests: DLPC tests (Trail Making Test, Letter-Number Sequencing, Five Digit Test, Zoo Map, and R-SAT) and the VMPC test (IGT). Scores on the subscales of the Constructive Thinking Inventory (Global Constructive Thinking, Emotional Coping, Behavioral Coping, Superstitious Thinking, Categorical Thinking, Esoteric Thinking, and Naive Optimism) were used to try to predict executive function scores.

RESULTS

Description of the non-clinical sample

Table 1 includes the means of the main sociodemographic variables and the scores obtained on the subscales of the SCL-90 Symptom Checklist.

Predictor variables for performance on tests of dorsolateral prefrontal cortex executive function

To find out which constructive thinking subscales best explained scores on tests of DLPC executive function, we carried out multiple regression analyses using the stepwise method. Dependent variables were the scores on the Trail Making Test (forms A and B), the Five Digit Test, Letter-Number Sequencing, the Zoo Map Task, and the R-SAT (R-SAT brief items and R-SAT action-slips), whereas independent variables were the scores on the subscales of the Constructive Thinking Inventory. Results revealed that

Table 1. Means and standard deviations of the sociodemographic variables and SCL-90[a]

Variables	Mean	SD
Age	42.06	11.80
Years of education	15.56	3.44
Somatizations	57.22	10.09
Obsessions and compulsions	60.56	8.53
Interpersonal sensitivity	57.51	10.94
Depression	56.72	10.86
Anxiety	58.24	10.18
Hostility	55.53	10.60
Phobia	49.94	12.35
Paranoid ideation	55.72	11.62
Psychoticism	57.44	11.11
Global Severity Index	59.25	10.66
Positive Symptom Distress Index	48.68	10.28
Positive Symptom Total	62.87	10.55

[a]SCL-90-R Symptoms Inventory (Derogatis, 1994).

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Table 2. Selected independent variables (Constructive Thinking Scales) that predicted performance in various dorsolateral prefrontal cortex-mediated tests of executive function

DLFC tests	Constructive thinking variables	R^2	R^2 corrected	β	t	p
Trail A	Esoteric Thinking	0.091	0.073	0.301	2.255	0.028
R-SAT brief items	Emotional Coping	0.077	0.059	0.277	2.061	0.044
R-SAT action-slips	Categorical Thinking	0.104	0.087	0.323	2.435	0.044

Note: DLFC, dorsolateral prefrontal cortex; Trail A, Trail Making Test, Form A; R-SAT brief items, percentage of brief items on the Strategies Application Test; R-SAT action-slips, number of mistakes on the Strategies Application Test.

Esoteric Thinking was the only variable with explanatory-predictive value for Trail A. This relationship was positive [$R^2(53) = 0.091$; $F(1,51) = 5.084$; $p = 0.028$], and evidenced that the higher the Esoteric Thinking score, the longer the subject took to complete the Trail A subtest (see Table 2).

With regard to R-SAT performance, the results showed that Emotional Coping was the only variable with explanatory-predictive value. The positive relationship obtained [$R^2(53) = 0.077$; $F(1,51) = 4.249$; $p = 0.044$] indicated that higher Emotional Coping scores were associated with the completion of more brief items on the R-SAT. Results also showed that the Categorical Thinking scale predicted R-SAT action-slips. As shown in Table 2, the relationship between the Categorical Thinking scale and R-SAT action-slips was positive, showing that the higher the Categorical Thinking score, the higher the error rate on the R-SAT [$R^2(53) = 0.104$; $F(1,51) = 5.931$; $p = 0.018$].

We did not find any other predictor variable that explained the scores on tests of DLPC execution function.

Predictor variables for performance on a test of ventromedial prefrontal cortex executive function

To find out which Constructive Thinking scales best explained the score on the IGT, the test of VMPC executive function, we carried out multiple regression analyses using the stepwise method. Dependent variables were the scores on the IGT, and predictive variables were scores on the Constructive Thinking subscales. No scores of the Constructive Thinking subscales had predictive value with respect to the decision-making processes involved in the IGT, which presumably engage the VMPC.

DISCUSSION

The purpose of this study was to relate constructive thinking with the various components of executive function, as these two broad concepts might be functionally related and their putative association had not been previously investigated. Constructive thinking is a measure of emotional intelligence that reflects the ability of an individual to successfully adapt to different aspects of a given situation. As such, constructive thinking could be related to the notion of cognitive flexibility within the domain of executive function. Conversely, superior performance on tasks requiring updating, set shifting, planning, or decision making, all of them distinctive aspects of executive function, could indicate that an individual is characterized by optimal constructive thinking.

According to the results of this study, some constructive thinking subscales were able to predict distinct executive function variables. On the one hand, regarding DLPC executive function, the Emotional Coping subscale was able to predict the high performance on the R-SAT, so that the higher the Emotional Coping, the better the decision making measured by the R-SAT. Categorical Thinking was found to predict mistakes in the R-SAT action-slips, indicating that the higher the categorical thinking, the more errors and, therefore, the lower the capacity for response inhibition. Although the Esoteric Thinking subscale explained performance on the Trail Making Test, Form A, no significant results were obtained from the rest of the DLPC-mediated tasks and VMPC-mediated tasks.

A significant relationship was observed between the Esoteric Thinking scale and scores on the Trail Making Test, Form A, such that increasing scores on the Esoteric Thinking scale were associated with declining performance in a timed task of visual and motor control. These results are in line with those of Musch and Ehrenberg (2002), who found that lower cognitive ability correlated substantially with belief in the paranormal.

Our data also show a positive relationship between Emotional Coping, which is the subscale closest to the global scale, and R-SAT performance. This association could be interpreted as suggesting that those individuals with high levels of Emotional Coping might face potentially stressful situations as a challenge rather than as a threat, thus experiencing less strain under those conditions (Epstein, 2001). It is this type of constructive and adaptive thinking that is required for appropriate decision making in our daily lives, and it also appears to be reflected in optimal performance in decision-making tasks in the laboratory.

Finally, R-SAT *action-slips* were associated with the Categorical Thinking scale, a constructive thinking scale characterized by rigid thinking and a tendency to give simplistic solutions to problems. Errors committed on the R-SAT could be related to high levels of Categorical Thinking, given that lower levels of response inhibition leading to error-prone performance on the R-SAT could be due to inflexible thinking leading to persistence in people's ways of executing the task, without correcting their errors.

This is the first study designed to determine whether there is a relationship between constructive thinking and executive function per se. Other studies that have focused on the relationship between a given issue (e.g., drug abuse) and a deficit in executive function and/or constructive thinking did not establish a relationship between the latter two. In the face of the promising results obtained herein, the sample could be increased and the study extended to clinical populations.

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In conclusion, the contribution of our investigation derives from our finding that constructive thinking predicts the performance on DLPC-mediated executive function tests of selective attention and response inhibition. These results have implications not only at the experimental level but also at the clinical level, as the connection between emotional intelligence-related variables, such as constructive thinking, and the decision-making process appears to suggest that those who fail to develop an adequate level of emotional intelligence could be prone to making deficient decisions in their daily lives. Therefore, by developing intervention programs to improve people's constructive thinking and emotional intelligence, we could optimize their decision making. We strongly believe that this possibility should be addressed in future research.

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Authors' biographies:

Ana Santos-Ruiz is a PhD student in the Department of Psychology of the University of Granada in Spain. Her doctoral training has focused on clinical psychoneuro-immunology and neuropsychology. Her research interests concern executive function and stress, in both healthy people and patients with disorders of the immune system.

Maria José Fernández-Serrano obtained the European Doctorate in Psychology at the University of Granada. Currently, she is a postdoctoral research fellow at the University of Jaén. She has been investigating the neuropsychological effects of drug addiction since 2005.

Humbelina Robles-Ortega has a PhD in psychology (1991) from the University of Granada and is an associate professor in the Department of Clinical Psychology. She has authored research articles in ISI journals like *International Journal of Psychophysiology*, *Psychosomatics and Psychotherapy*, *Neuropsychologia*, *The Spanish Journal of Psychology*, *Salud Mental*, as well as book chapters and books on stress, health, and human psychophysiology.

Miguel Pérez-García is a PhD in psychology and Professor of Clinical Neuropsychology at the University of Granada (Spain). His research interests are related to the assessment of executive function as it relates to addictive behaviors, neurological and psychiatric diseases, and developmental disorders.

Nuria Navarrete-Navarrete holds a PhD in Internal Medicine from the University of Granada and is a medical doctor and expert in autoimmune diseases in the University Hospital "Virgen de las Nieves." She has been investigating psychological variables, specifically stress effects, in systemic lupus erythematosus. She has authored research articles in ISI journals (*Lupus, Psychotherapy and Psychosomatics, Journal of Rheumatology, Medicina Clinic*a).

Maria Isabel Peralta-Ramírez holds a PhD in Psychology (2002) from the University of Granada and is an associate professor in the Department of Clinical Psychology (1999 to the present). She is the author of 17 research articles in ISI journals such as *Psychosomatic Medicine*; *Lupus*; *and Psychotherapy and Psychosomatics*. She is also actively participating in four national projects on "stress and emotion."

Authors' addresses:

Ana Santos-Ruiz, Humbelina Robles-Ortega, Miguel Perez-Garcia and Maria Isabel Peralta-Ramirez Department of Clinical Psychology, University of Granada, Spain.

Maria Jose Fernandez-Serrano Department of Psychology, University of Jaen, Spain.

Nuria Navarrete-Navarrete University Hospital "Virgen de las Nieves", Granada, Spain.

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