Forensic neuropsychology at the challenge of the relationship between cognition and emotion in psychopathy

M.A. Alcázar-Córcoles [a,b], A. Verdejo-García [c], J.C. Bouso Saiz [d]

FORENSIC NEUROPSYCHOLOGY AT THE CHALLENGE OF THE RELATIONSHIP BETWEEN COGNITION AND EMOTION IN PSYCHOPATHY

Summary. Introduction. *The relationship between frontal lobe damage and criminality is especially complex. The neural substrates of psychopathic behavior seem to involve structural and functional abnormalities in the frontal lobes and the limbic system.* Aim. *To analyze the repercussions that brain structural and functional abnormalities in psychopathic individuals may have for forensic neuropsychology.* Development. *Consistent evidence indicate that response inhibition problems in psychopathic subjects are linked to structural or functional damage in the frontal cortex. Furthermore, the prefrontal cortex, along with the amygdala and the hippocampus forms the limbic system, which is an important neural substrate of emotion processing; therefore the psychopath's capacity of affective processing could also be impaired. The theoretical frameworks of the somatic marker and mirror neuron hypotheses, along with the empirical study of executive functions may contribute to explain the inability of the psychopathic subjects to feel empathy, which is one of the main inhibitors of violence and antisocial behavior.* Conclusions. *The relationship between frontal lobe dysfunction and antisocial behavior arises an important legal issue. In order to consider some type of minor liability in the case of psychopaths it is suggested to gather further research data about the relationship between frontal lobe dysfunction and the ability to inhibit antisocial behavior by making an adequate use of empathy and emotional ties. [REV NEUROL 2008; 47: 607-12]*

Key words. *Antisocial behavior. Cognition. Emotion. Executive function. Forensic neuropsychology. Psychopathy.*

INTRODUCTION

On September 13, 1848, Phineas P. Gage suffered a terrible accident when an iron rod went through his skull and produced a severe damage in his brain, changing his life after a surprising recovery. Gage´s lesions were located in brain frontal regions. From that moment on Gage's personality changed dramatically: from being an adapted, responsible and, to put it briefly, a person well adjusted to society, he transformed into an unstable and impulsive individual, barely interested in others and unable to plan ahead; therefore, he showed opposite behaviors to an appropriate social insertion. This way, Gage marked the beginning of the research related to the relationship between the frontal lobe and psychopathic behaviors. In conclusion, Gage lost the ability to notice the changes that had been produced in his personality, as if he had lost the capacity of looking at himself in the mirror of other' s reactions and responses to him [1,2].

The relationship between damage in the frontal lobe and criminality is eespecially intriguing and complex. It is known that damage in the frontal lobes leads to the deterioration of intuition, impulse control and planning, which usually drives to an unacceptable social behavior. This is eespecially true when the damage affects the orbital surface of the frontal lobes. The patients that suffer this 'pseudopsychopathic' syndrome are characterized by their request of immediate reward and don't seem to be restricted by social habits or fear of punishment, therefore they seem similar to the pattern of behavior shown by Gage after his lesion [1,3,4].

The executive functions (EF) are neuropsychological processes involved in goal setting, activity planning and successful behavior monitoring and performance. As revealed by neuroimaging techniques indicate, the anatomical substrates of psychopathic behavior rely on structural or functional differences on the medial prefrontal cortex, a brain region involved in the emotion-cognition interface, self-regulation, reversal learning and decision-making. In this sense, the psychopath may suffer a deficit in the integration of the emotional world with reasoning and behavior [5-16].

The aim of this revision is the analysis of the repercussions that structural and functional abnormalities in psychopathic individuals may have for forensic neuropsychology.

THE CONCEPT OF PSYCHOPATHY

Individuals diagnosed of psychopathy do not suffer a loss of contact with reality and neither do they experience the characteristic symptoms of psychosis, such as hallucinations, illusions or deep subjective discomfort and disorientation. In contrast to psychotics, psychopaths are completely rational and conscious about what they do and the reasons why they act. Their behavior is the result of their personal choice, freely performed, consequently becoming the most perfect predator of his own species [7,17-20].

Despite the conceptual and methodological difficulties that have historically burdened this field of investigation, at present

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[a] *Psychologist of the Fiscalía and Juzgado de Menores de Toledo. Ministerio de Justicia de España.* [b] *Departamento de Psicología Biológica y de la Salud. Facultad de Psicología. Universidad Autónoma de Madrid.* [c] *Departamento de Personalidad, Evaluación y Tratamiento Psicológico. Facultad de Psicología. Universidad de Granada.* [d] *Centro de Investigación del Medicamento. Instituto de Investigación. Hospital de la Santa Creu i Sant Pau. Barcelona, España.*

Corresponding author: Dr. Miguel Ángel Alcázar Córcoles. Departamento de Psicología Biológica y de la Salud (despacho 23). Facultad de Psicología. Universidad Autónoma de Madrid. Ivan Pavlov, 6. E-28049 Cantoblanco (Madrid). E-mail: miguelangel.alcazar@uam.es

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there is an extensive body of research that endorses its importance in clinical and forensic contexts. From the ideas of Cleckley [21] and, especially, from the conceptual and methodological developments of Robert Hare, psychopathy has been defined as a spectrum of affective, interpersonal and behavioural traits highly significant in the study of adult antisocial behavior. Scientific literature currently offers many data that show the usefulness of this construct to identify offenders with severe indicators in their criminal career, including high delinquency rates, likely violent offending, aggression in the context of prison, high tendency to recidivism and poor treatment response [19,20,22-25].

Research reveals that psychopathy comprises two types of trait groups. The first one includes the emotional or interpersonal area and the second refers to an antisocial style of life [7,22]. Hare has created an instrument for the detection of psychopaths, the Psychopathy Checklist (PCL) [26]. It is made up of two factors. Factor 1 reveals affective and interpersonal features, such as egocentrism, absence of regret, etc. Factor 2 shows impulsivity, antisocial behavior and an unstable style of life and it is positively associated with the diagnosis of antisocial personality disorder, criminal behaviors, lower socio-economic class and antisocial behavior displays [26-28]. Recently, a computerized version of Hare's scale (PLC-R) has been applied to a broad sample of 8000 participants following the item response theory [26,29]. The findings from this study indicate that the scale suitably discriminates between males belonging to forensic psychiatric population males, criminal males and males who committed a crime in the past.

Rober Hare [20] concludes that psychopathy is one of the better validated clinic constructs in the context of psychopathology and, undoubtedly, the most important within the criminal justice system. Other authors agree with this opinion and consider that the psychopathic offender is special, qualitatively different from other offenders [30-32].

Patrick [33] while going through the studies of psychopathy and emotion, points out that the individuals that show the main characteristics of the 'emotional indifference' factor of psychopathy have got a higher threshold for the defensive reaction. Lykken [34] suggested that the main deficit of the 'primary' (real) psychopaths is that they barely feel fright. Not everyone is as fearful as others. On one hand, this is due to the defensive system opposing the approach system: on the other hand, to the adaptive value that a weakening of the avoidance system has under certain circumstances. Therefore, when the resources are scarce psychopaths might be considered as predator individuals that are eespecially adapted to survive in spaces where resources are poor and the tendency to approach must prevail unless danger is imminent. So, the principal violence and antisocial behavior inhibitors (empathy, emotional ties, fear of punishment, feeling guilty, etc.) are non-existent or very poorly expressed in psychopaths. This fact may explain why psychopaths represent only one percent of the total population, whereas this rate rises to 25% within the prison population [27,35-37].

NEUROPSYCHOLOGICAL BASES

Raine et al used structural magnetic resonance in a sample of 21 psychopathic patients and found that they showed an 11% reduction in the frontal cortex gray matter without the appearance of any other brain lesion. Therefore, they suggested that this prefontal structural deficit might be the basis for the low arousal, poor fear conditioning, lack of remorse and self-control problems that characterize antisocial and psychopathic behavior. The origin of this reduction is uncertain, although the authors claim that this reduction is at least partly congenital, rather than due to environmental factors, such as parental abuse. Consequently, people with certain congenital brain dysfunctions might be eespecially predisposed to antisocial behavior [3,38].

Research carried out with functional magnetic resonance (fMRI) are beginning to provide evidence of neurobiological factors associated with psychopathy. In this vein, Liddle et al [39] found out that response inhibition in non-psychopaths was associated to increased dorsolateral prefrontal activity. Nevertheless, there wasn't a significant decreases of the cortical activity in psychopaths during the response inhibition. Although the test was simple and the psychopaths performed well, the authors consider that it was possible that the results could get increasingly worse as the tasks adjusted to real life demands, where the environment which allows inhibiting certain harmful contexts for the self or for others are usually highly emotional. The response inhibition involves the integration and active cooperation of many regions, including the frontal, ventromedial and dorsolateral cortex. In this aspect, these authors suggest that the connections between the ventromedial prefrontal cortex and the lateral regions contribute to decision-making. They have an influence, for example, in response modulation, behavior planning and in attention. Researchers highlight that the control of the right response performance and the inhibition of the wrong responses is located in the ventromedial and dorsolateral prefrontal regions. The first region is essential in adaptive behavior from natural selection's perspective and it involves emotional decisions, whereas the second is in charge of planning decisions and actions that derive from it. Therefore, it might be concluded that the psychopath's disinhibited behavior is related to a ventromedial prefrontal cortex (cognitive-affective integration) and dorsolateral prefrontal cortex (response inhibition) malfunctions and/ or to an ineffective communication between these and other regions of the brain. In a certain way, it could be considered that psychopaths suffer difficulties to connect cognitive and emotional brain areas. In a recent fMRI research it was found that a group of adolescents with psychopathic traits exposed to a reversal learning task showed a higher activity in the ventromedial prefrontal cortex during incorrect trials in which they received punishment [2,27,39-42].

Raine [43] claims that psychopaths tend to show a reduced functioning rate in left hemisphere regions and higher functioning in right hemisphere regions of the amygdala, the hippocampus and the thalamus. The amygdala has been repeatedly associated with aggressive behavior, in both animals and human. The amygdala is integrated in a key neural network to process socially relevant information and operates simultaneously with the object-recognition system of the hippocampus. The disturbance of this system may be partly related with an inappropriate social behavior that some individuals show, as well as the impairment to recognize and correctly assess certain social stimuli that can give rise to conflicts. The amygdala, the hippocampus and the prefrontal cortex are integrated in the limbic system which controls emotion expression, whereas the thalamus transmits input from the limbic subcortical structures to the prefrontal cortex. Likewise, the hippocampus, the amygdala and the thalamus are critical for learning, memory and attention.

Abnormalities in their functioning can be related both to the deficit to produce fear conditioning responses and to the inability to learn from experience; these deficits characterize violent offenders [44-47].

Raine et al [48] carried out a research where a group of murderers was divided in two: predator and affective individuals. The first ones are controlled murderers that tend to plan their crime, lack affection and are more likely to attack a stranger. On the contrary affective murderers act in a less-planned way and under an intense emotion, mainly in home context. The authors found that the affective murderer's prefrontal cortex exhibit low activity rates. On the other hand, the predator murderers had a relatively good prefrontal functioning, which corroborates the hypothesis that an intact prefrontal cortex allows to maintain under control their behavior, adapting it to their criminal aims. Both groups are chracterized by higher activity rates in the right subcortex (defined as the mid-brain, the amygdala, the hippocampus and the thalamus) than the control group. Because of this higher subcortical activity, the murderers from both groups may be prone to aggressive behavior, but the predator murderers have got a comparatively good prefrontal functioning to regulate their aggressive impulses manipulating others to reach their own goals [43].

THE SOMATIC MARKERS HYPOTHESIS

Somatic states are emotional signals that juxtapose in the processing of a cognitive setting and help to choose a course of action, activating the working memory and biasing the representation of the possible outcomes. Within the hypothesis, these emotional signals, which stem from biological homeostasis, are called somatic markers. The concept 'somatic' includes both musculoskeletical and visceral structures and their neuropsychological representation in the central nervous system. This way, the somatic markers hypothesis is a neuropsychological model that, applied to psychopathic behavior, provides a powerful integration of motivational, affective and information processing factors [49-51].

In order to prove the somatic marker hypothesis, a sample of 157 males classified according to their PCL score was used. They were assessed with the Iowa Gambling Task, a neuropsychological probe of emotion-based decision-making. The authors concluded that it was the level of anxiety –and not the scoring on psychopathy– which predicted the response election [26,52-54].

THE MIRROR NEURONES HYPOTHESIS

In the recently-published book, *The mirror neurones* [55], it is proposed that the cortical area known as the insular lobe, located at the lateral or Sylvian fissure, might have a key role in self and other's emotion recognition. Similarly to the neuronal circuits which store specific memories, these groups of mirror neurons seem to code specific action patterns. This ability might not only allow to make basic movements which are not the result of thinking but, also, understanding these same acts in other person without the need of reasoning. The insula represents the primary cortical area not only for the chemical exteroception (senses of smell and taste), but also for the interoception. That is, the reception of signs regarding the internal states of the organism [55,56].

Hutchison et al [57] recorded the activity of certain neurons in several patients who, due to therapeutic reasons, had to undergo a partial ablation of cingulate cortex. The result was that there were neurons –in the anterior region of this cortex– which responded both to the painful-stimuli application in the patient's hand and to the observation of the same stimuli applied to other individuals. More recently, Singer et al [58] carried out a fMRI experiment where two situations were tested: in the first, the subjects received a painful electroshock through electrodes on the hand, whereas in the second the subjects saw a relative's hand with the same electrodes. These subjects were told that the observed people had suffered from the same procedure that they had just experimented. It was confirmed that, in both experimental situations, anterior insula and anterior cingulate cortex sectors became activated, which proves that the direct perception of suffering as well as its evocation are carried out by a mirror mechanism.

AN INTEGRATIVE PROPOSAL

Taken as a whole, the data suggest that human beings grasp emotions, at least intense negative emotions, by means of a direct mapping mechanism in which parts of the brain which generate visceral motor responses are involved. Therefore, it is not difficult to notice the evolutive (surviving) advantages of a mechanism based in mirror neurons which sets the essential motor actions within a higher extension semantic network because of a powerful reason: it facilitates the direct and immediate interpretation of someone else's behaviors without the need of complex cognitive processes. In social life, the correct interpretation of others' emotions is really important; in fact, emotion is usually a key contextual element that marks the purpose of an action [40,56,59-63].

Likewise this interpretation of emotion-comprehension is not far from the one proposed by Antonio Damasio and his collaborators. According to Damasio's group, both feeling an emotion for one's self as well and recognizing another person's emotion would depend on the implication of the somatosensory cortex and insula regions. The observation of other's faces expressing an emotion would determine the mirror neurons activation in the premotor cortex. These neurons would send a copy of the activation pattern, similar to the one they send when the observer experiences the emotion, to the somatosensory areas and to the insula. The resulting activation of the sensory areas, similar to the one occuring when the observer spontaneously expresses this emotion would be anchored in the understanding of the others' emotive reactions [64-66].

Furthermore, our motor system activates with other's facial movements. However, this happens as well when these haven't got any emotional value. Consequently, Rizzolati y Sinigaglia [55] consider that proposing a sensory cortex involvement in other's emotion recognition is a redundancy. The information from the visual regions which describe the faces or bodies expressing emotion arrive directly to the insula, where they activate an autonomous and specific mirror mechanism which is able to immediately code these data into their emotive corresponding formats. The insula is the center of this mirror mechanism since it is not only in the cortical region where the internal states of the body are represented, it also constitutes a visceromotor integration center whose activation leads to the transformation of sensorial *input* to visceral *input*. The results of a re-

cently-published article might be interpreted coherently. It was found that the *CREB1* gene polimorfism is related to activity abnormality of the leftward insula at the exposition of anger facial expressions [67].

Singer's et al results [58] show that such reactions are the ones that describe both the subjects' emotive responses and their perception of others' emotive responses. We must point out that this does not mean that our brain is not able to distinguish others' emotions without the insula. But, quoting William James [68], in this case, the latter would be reduced to be 'purely cognitive in form, pale, colorless, destitute of emotional warmth'. Such emotive colour depends indeed on the action of sharing visceromotor responses that contribute to defining emotions.

Empathy is the ability to feel the same emotion of pain and shudder from the same perspective of the suffering person. Nevertheless, in order to experience empathy it is not enough to share the other's perspective, that is to say, being able to put yourself in someone's imagination at the event that affects him, but it requires certain worry about the other's sorrow. Psychopaths are able to imagine what the other person thinks and feels about a situation, but they might use this as a weapon for manipulation: if the psychopath is able to anticipate what other person imagines and feels, he may create a more perfect plan to manipulate and take advantage of the victim. Empathy requires a community of feelings: the individual that shows empathy is able to feel that there is a human being in front of him that feels something and is able, as well, to feel these same things [69]. Thus, empathy is the most powerful inhibitor against violence and cruelty that is known. Consequently, mirror neurons might be at the heart of empathy and may present some type of abnormality in psychopaths [7,17,18,27,70,71].

CONCLUSIONS

Several studies that show the possible existence of structural and functional abnormalities related to psychopathy are presented in this review. Research with neuroimaging techniques has obtained results compatible with the possible brain dysfunction in psychopaths. Data point out dysfunctions in the frontal lobe and amygdala and a prefrontal cortex volume's reduction and changes in components of the limbic system involved in emotional processing.

The EF integrates emotional and cognitive processes, and prefrontal lesions are associated to damaged decision-making and emotion expression. It has been recently proved, by means of meta-analysis, the relationship between antisocial behavior and difficulties in tasks which demand the EF participation. Therefore, psychopaths are a clear example of the relationship between cognition and emotion. Their particular emotion processing is accompanied by dysexecutive signs [3,5,6,10,11,14, 45,72-74].

The link between frontal lobe dysfunction and antisocial behavior arises an important legal issue. In a legal sense, a 'frontal' patient might be able to go to court, because he can understand the legal process. In a rhetoric way, he might also be able to distinguish right from wrong and could answer in a proper way to the questions concerning what actions are acceptable and which are not. It is very likely as well, that the patient would have this knowledge available in a simbolic way even in the moment of the crime. Consequently, a defence claiming mental disorder could not be applicable in a conventional way. But the frontal damage might have interfered in the ability of transforming this knowledge into an admissible social action. Although the difference between right and wrong is known, this knowledge can not be translated to effective inhibitions. Consequently, Goldberg [3] proposes a new legal construct: 'impairment to guide the one's behavior although the required knowledge is available' to collect the particular relationship between frontal lobe damage and potential criminal behavior. Research about frontal lobe disorders gather under the same focus neuropsychology, ethics and law. As the legal profession is increasingly more instructed about the brain functioning, the defence based on the frontal lobe might emerge as a legal strategy along with the defense based in transitory mental disorder [3]. This proposal is coherent with professor Raine's expositions: criminal behavior must be tackled as a clinical disorder [75].

However, along with several authors [7,17,18,76-79], we consider that psychopaths are entirely liable because, although they might present dysfunctions in their nervous system, this would not force them to be aggressive nor criminal. This might only facilitate the setting up of psychopathic personality patterns through the history of learning along the subjects' development. Consequently, we acknowledge the challenge posed by the research in psychopathology and forensic neuropsychology to continue gathering evidence and studying the relationship between cognition and emotion in psychopathic personality in order to specify the particular cases to consider some type of minor liability [76,80-82].

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LA NEUROPSICOLOGÍA FORENSE ANTE EL RETO DE LA RELACIÓN ENTRE COGNICIÓN Y EMOCIÓN EN LA PSICOPATÍA

Resumen. Introducción. *La relación entre daño en el lóbulo frontal y criminalidad es particularmente compleja. El sustrato anatómico subyacente al comportamiento psicopático se refleja en diferencias estructurales y funcionales vinculadas al lóbulo frontal.* Objetivo. *Analizar las repercusiones de las alteraciones estructurales y funcionales del lóbulo frontal en los sujetos psicópatas para la neuropsicología forense.* Desarrollo. *Hay un cuerpo de investigación coherente que sugiere que los problemas de inhibición de los psicópatas se vinculan con daños estructurales o funcionales en la corteza frontal. Por otra parte, la amígdala, el hipocampo y la corteza prefrontal se integran en el sistema límbico, que gobierna la expresión de las emociones, por lo que los psicópatas también podrían ver afectada su capacidad de procesamiento afectivo. Las hipótesis de los marcadores somáticos y de las neuronas espejo, junto con el estudio de la función ejecutiva, podrían revelar las deficiencias de los psicópatas para experimentar empatía, que es uno de los principales inhibidores de la violencia y la conducta antisocial.* Conclusiones. *La conexión entre disfunción del lóbulo frontal y comportamiento antisocial plantea una importante cuestión forense. En el caso de los psicópatas, para que se pueda considerar algún tipo de menor responsabilidad legal se sugiere seguir acumulando datos de investigación de la relación entre disfunción del lóbulo frontal y capacidad de inhibir la conducta antisocial haciendo un correcto uso de la empatía y de los vínculos emocionales. [REV NEUROL 2008; 47: 607-12]*
Palabras clave. *Cognición. Conducta antisocial. Emoción. Función ejecutiva. Neuropsicología forense. Psicopatía.*