

## Violent and/or delinquent women: a vision from the biopsychosocial perspective

Virginia Soldino, Ángel Romero-Martínez\*, and Luis Moya-Albiol

*Department of Psychobiology, University of Valencia (Spain).*

**Título:** Mujeres violentas y/o delincuentes: una visión desde la perspectiva biopsicosocial.

**Resumen:** La violencia y/o delincuencia en mujeres ha estado enmascarada en cierta medida por la sociedad. Por ello, el objetivo fundamental de este trabajo es analizar en profundidad los trabajos publicados al respecto, con el fin de comprender dicho fenómeno desde una perspectiva neurobiológica. En primer lugar, se analizará la teoría del ciclo de la violencia como mecanismo facilitador de la violencia en mujeres, con especial énfasis en los correlatos neuroanatómicos. Posteriormente, se expondrá la relación existente entre el consumo de drogas y la violencia en mujeres. Por último, se expondrán de forma exhaustiva los principales correlatos biológicos conocidos como mecanismos facilitadores de la violencia en mujeres. Los principales factores de riesgo para la facilitación de la violencia y/o delincuencia en mujeres son las experiencias de maltrato durante la infancia y el consumo de drogas. Además, niveles altos de cortisol y testosterona y bajos de serotonina y oxitocina, serían correlatos de dicha violencia. Por otra parte, se ha descrito dos tipos de agresoras en función de la respuesta del Sistema Nervioso Autónomo, las premeditadas que presentan una baja reactividad y las impulsivas que presentan una hiperreactividad psicofisiológica. Al tratarse de un problema complejo y poco estudiado se hace necesario aumentar el cuerpo de conocimientos en dicha temática, con el objetivo de desarrollar programas de tratamiento y/o prevención efectivos.

**Palabras clave:** Delincuencia; Marcadores psicobiológicos; Mujeres; Sustancias de abuso; Violencia.

**Abstract:** Violence and/or delinquency in women have been masked to some extent by society. Thus, the main goal of this work is to deeply analyse the published works on these matters, in order to understand this phenomenon from a neurobiological perspective. Firstly, the theory of the cycle of violence as a facilitating mechanism of violence in women will be analysed, with a special emphasis on neuroanatomical correlates. Subsequently, the relation between drug consumption and violence in women will be explained. Finally, the main biological correlates known as facilitating mechanisms of violence in women will be exhaustively described. The main risk factors for the facilitation of violence and/or delinquency in women are mistreatment experiences during childhood and drug consumption. Furthermore, high levels of cortisol and testosterone and low levels of serotonin and oxytocin would be correlates of that violence. On the other hand, two types of aggressors have been described according to the response of the Autonomic Nervous System: the premeditated ones, who present a low reactivity, and the impulsive ones, who present a psychophysiological hyper-reactivity. As it is a complex and insufficiently studied issue, increasing the corpus of knowledge in this topic is necessary with the objective of developing effective programmes of treatment and/or prevention.

**Key words:** Delinquency; Psychobiological markers; Women; Substances of abuse; Violence.

### Introduction

Violent women have been considered as a secondary topic within psychological and criminological studies. Actually, for a long time it has remained on the sidelines in most of the researches about human violence. The small number of cases of violent women reflected in scientific literature and mass media, as well as the lower proportion of women in prison as compared to men makes the development of research in this topic more difficult (Lorenzo-Moledo, 2002). Furthermore, the legal-penal regulation and the culture of origin and/or reference is not the same in all societies. Thus, a component of specificity about what violent and criminal behaviours are would exist (de la Cuesta-Aguado, 1992; Horn, Puffer, Roesch and Lehman, 2014; Tsapelas, Fisher and Aron, 2011), as well as the interpretation and/or justification made by researchers belonging to different cultures. Therefore, violence should be understood as a cultural expression and its manifestation and perception would vary according to the idiosyncrasy of the society and to the historical moment when it takes place.

If we only consider the cases of crimes against the person and of homicide, the number of women in prison remains low. Furthermore, the majority of these women belong to minority groups and have lived in poverty most of

their lives (Carlen, 1992). However, women can perpetrate violent acts such as domestic violence (Caldwell, Swan, Allen, Sullivan and Snow, 2009; Williams, Ghandour and Kub, 2008), infanticide (West, 2007), participate in drug trafficking and in some other kinds of organised crime similar to the men's, although their number would be smaller in contrast (Vizcaíno-Gutiérrez, 2010).

Weizmann-Henelius *et al.* (2003) classified violent women within three different groups according to their victims: women who had victimised someone closely related to them (as the result of interpersonal conflicts), those who victimise an acquaintance with no relation and those who had victimised a stranger, which usually occurs less frequently and who are usually weak and helpless victims, such as patients in a hospital or old people without relatives (Hickey, 2006). In all cases, we could find a previous record of criminality and substance abuse, anti-social personality traits and probably psychopathic traits.

They have been also classified depending on whether they acted accompanied or alone. Empirical data have revealed that female serial killers that act alone usually target adults belonging to their family, are motivated by the obtaining of a reward, use poisoning as the method and also usually perpetrate the murder in a specific place, such as their home or their workplace, to a larger extent than those who act accompanied. In particular, there are three different types: the "angel of death" (the murder occurs in a medical environment and with a patient as the victim), the "black widows" (whose motivation is instrumental and where the

**\* Dirección para correspondencia [Correspondence address]:**

Ángel Romero Martínez. Department of Psychobiology, University of Valencia. Avenida Blasco Ibañez, 21. 46010, Valencia (Spain).

E-mail: [Angel.Romero@uv.es](mailto:Angel.Romero@uv.es)

victim is a relative) and the infanticides (Björkqvist, Osterman and Kaukiainen, 1992; Kilty and Frigon, 2007; Pollak, 1950; West, 2007). With regard to the serial killers that act accompanied, they usually carry out their crimes locally (sometimes while they travel) and in a shorter time-span than those who act alone. Within this category there are several types of murderers such as the sexual sadists, the spree murderers (their murders occur in different places), those of the religious kind, the instrumental (Gurian, 2011) and those who are accomplice of male serial killers (Gurian, 2011; Hazelwood, Warren and Dietz, 1993; Jones, 2008).

The risk of recidivism in violent women has been observed to be high, especially if they are young or if they have been diagnosed with drug addiction or personality disorders such as depressive and behavioural disorders, as well as a high impulsiveness (Ariga *et al.*, 2010; Putkonen, Komulainen, Virkkunen, Eronen, and Lönnqvist, 2003; Salom *et al.*, 2014). Actually, violent women and men who also suffer from personality disorders are comparable in the risk of recidivism (23% versus 26%, respectively) (Putkonen, Komulainen, Virkkunen, Eronen and Lönnqvist, 2003). However, problems with accommodation, education and work and relationships with friends are more related to recidivism in men, while problems with emotional well-being would have major importance in the case of women (Van der Knaap, Albereda, Oosterveld and Born, 2012). Finally, there is a bias that has to be highlighted and it is that the majority of instruments used to assess the risk of recidivism in violent delinquents have been developed and validated in male samples.

On the other hand, the lack of awareness of the biological substrates that lie behind violent and/or delinquent behaviour in women is even higher, for most of the researches that have analysed the biological markers of violence have been focused on men (Moya-Albiol 2010), although currently gender and cycle phase are considered as important variables in the design of experimental studies. Thus, the goal of this work is to analyse, assess and synthesise the existing bibliography about violence and/or delinquency in women from a neurobiological perspective that includes, in addition to psychosocial factors, the main psychobiological correlates known until the present day. Firstly, the theory of the cycle of violence as a facilitating mechanism of violence in women will be analysed, with special emphasis on the neuroanatomical correlates. Then, the existing relation between drug consumption and violence in women will be described. Finally, the main biological correlates known as facilitating mechanisms of violence in women will be described in an exhaustive way. Throughout this paper, the information referred to both violence and delinquency in women will be included. However, we have to qualify that they are frequently related but they do not need to be always present. In this sense, the act of delinquency or law infraction does not need to be causally related to inflicting harm deliberately on oneself and/or others.

## Method

In order to make this revision a total of 104 articles have been used as a result of the search in three electronic databases such as PubMed (61), Dialnet (9) and Google Scholar (34). Most of the journals that have been part of this revision are categorised into two topics; the study of violent behaviour and forensic medicine and/or psychology.

The terms inputted for the Spanish search have been the result of the combination of these terms: “mujer”, “violencia”, “delincuencia”, “drogas”, “alcohol”, “cocaína”, “hormonas”, “neuropsicología”, “biología”, whereas the terms inputted in English have been: “female”, “women”, “violence”, “violent”, “aggression”, “homicide” and also adding, for several sections, “drugs”, “substance”, “alcohol”, “cocaine”, “MDMA”, “PCP”, “hormone”, “menstrual”, “testosterone”, “oxytocin”, “treatment”. Those articles in which only biological variables appeared without direct or indirect mention to the expression of violence in human, especially of women, were discarded.

## Topic development

### *The cycle of violence*

According to several authors, girls and women who transgress law and are violent can be, to an equal extent, victims and victimisers, for violence is a common characteristic in their vital trajectory (Azaola and José-Yacamán, 1996; Bailey and Eisikovits, 2014; Rivera, Kubiak and Bybee, 2014; Romero, 1998; Sommers and Baskin, 1993). Two variables that would facilitate the intergenerational transmission of violence acting as mediators are insecure attachment and the exaggerated believe that disagreements can destroy the couple (Sutton, Simons, Wickrama and Futris, 2014).

On the one hand, a recent study has disclosed that the intergenerational transmission of physical mistreatment would be higher in women than in men. Furthermore, the critical period for this transmission in women to take place would be after 13 years of age (Romero-Martínez, Figueroa and Moya-Albiol, 2014). On the other hand, being a victim of rejection, physical and/or sexual abuse from the first months of life to 11 years of age would increase the risk of delinquency and going to jail (Richie and Johnsen, 1996; Romero, 2003). Thus, the probability of going to jail for the victims of abuse during childhood would be around 20%, while the percentage in non-abused women would be around 11.4%. Moreover, these victims are twice as likely to be arrested when they are adults (28.5% versus 15.9%) and 2.4 more times to be arrested for violent crimes (8.2 % versus 3.6%) (Widom, 2000).

Having suffered any kind of violence during childhood, in any of its forms, leads to the frequent development of mechanisms of “derailment” in women, such as running away from home and lacking deficit in some cognitive abili-

ties (lower intelligence quotient and difficulties in reading skills). Some other behaviours could be developed, such as engaging in relationships with delinquent individuals, difficulties in the learning of necessary psychological and social skills for a sustainable adult development and/or the consumption of addictive substances (Burgess, Hartman and McCormack, 1987; Campbell, 2000; Widom, 2000). Thus, the future choices and decisions of women that present these deficits would be conditioned by their early experiences with their immediate environment (Romero, 2003).

The interruptions in the psychological and neurobiological development suffered during childhood could contribute to mistreated girls developing short-term and long-term psychopathological disorders, as well as to endangering the integrity of their physical and cognitive development. Women who have suffered from violence, regardless of whether it was during childhood or adulthood, have more risks to suffer from depression and anxiety (Campbell, Kub and Rose, 1996), stress, pain and phobias (Craig, 2007). Additionally, they are more prone to abuse substances and to develop antisocial personality traits (Galbraith and Rubinstein, 1996; Romero, Mondragón, Cherpitel, Medina-Mora and Borges, 2001; Staton, Leukefely and Logan, 2001). In line with these results, delinquent female teenagers present a longer history of mistreatment, abuse and/or children exploitation, which leads to low self-esteem and accumulation of risks to commit more criminal acts. The personality of young female offenders presents a dual functioning, coexisting styles linked to transgression alongside others related to affliction and emotional vulnerability (Cruise, Marsee, Dandreaux and DePrato, 2007; Stefurak and Calhoun, 2007; Vinet and Alarcón, 2009). Furthermore, the group has shown a low control of impulses and a low suggestibility in contrast with non-violent adolescents (Stephenon, Woodhams and Cooke, 2014). Finally, the top crimes among female adolescents are those against the property in the modalities of aggravated robbery and theft (Odgers *et al.*, 2007; Serrano, 2009; Vinet and Alarcón, 2009), but their crimes are smaller in number and seriousness than those of male adolescents (Vinet and Alarcón, 2009; Vandiver, 2010).

From the neurobiological point of view, the main changes as a consequence of children mistreatment at the central nervous system stage observed in women would affect structures such as the corpus callosum, the hippocampus and the amygdala (Mesa-Gresa and Moya-Albiol, 2011). Firstly, it was observed that women with a history of sexual abuses presented a decrease in the volume of the corpus callosum in contrast with control women (Mesa-Gresa and Moya-Albiol, 2011). Moreover, the left hippocampal volume of women who had suffered from abuses and have developed a posttraumatic stress disorder (PTSD) was 19% lower than that of control women. In relation to the hippocampus, women with borderline personality disorder and a history of children mistreatment presented a bilateral decrease of the hippocampal volume. This disorder would be highly related to the perpetration of violent acts such as suicide and recidi-

visism in criminal acts (Fazel, Lichsteinstein, Grann, Goodwin and Langström, 2010). Regarding the amygdala, a major activation of the left side was registered during the acquisition of fear and lower one in the cingulate cortex during its extinction in women with a secondary PTSD derived from sexual abuse in childhood in contrast with control women (Mesa-Gresa and Moya-Albiol, 2011).

Most of the brain changes observed in mistreated children (boys and girls) are also observed in violent adults. According to Davidson, Putnam and Larson's model (2000), structural and functional alterations of the neural circuit regulating emotion (composed by the prefrontal cortex, the amygdala, the hippocampus, the hypothalamus, the anterior cingulate cortex and some other interrelated structures) can increase the risk of showing aggressive and violent behaviours of the impulsive type, but not of the premeditated type. The alterations in these brain structures underlie the deficits in executive functions, which would be vital for socialisation processes. The deficits in these cognitive processes would be related to a worse control of impulses and anticipation of the consequences, so the manifestation of violence is facilitated (Romero-Martínez and Moya-Albiol, 2013). For its part, the amygdala is important in fear conditioning and in the control of aggressive and sexual behaviours, so the behaviours of episodic dyscontrol and impulsive violence could have their focus on the hyper-responsiveness of this structure (Rodríguez-Delgado, 1981; Teicher *et al.*, 2003). In mistreated girls, in comparison with the non-mistreated, this chronic activation of the amygdala could deteriorate the development of the prefrontal cortex, which in turn could trigger alterations in the acquisition of behaviours and emotions depending on the age, including the control of the impulses (De Bellis, 2005). These girls would be prone to show violent and impulsive behaviours during adulthood.

Thus, the smaller size of the corpus callosum observed in mistreated girls could trigger the independent development of both hemispheres (Grassi-Oliveira, Ashy and Stain, 2008), which could be related to the data obtained in violent adults, in whom a lower lateralisation is seen in respect of language in tasks that imply verbal processing, as well as a decrease in the metabolism of glucose in the corpus callosum in murderers' samples (Raine and Buchsbaum, 1996).

On the other hand, the decrease of the volume of the hippocampus and of the amygdala in the temporal lobe of subjects victims of mistreatment during childhood (Bremner *et al.*, 2003, Carrion *et al.* 2001; Weniger; Lange, Sachsse and Irle, 2008) could contribute to the development of violence in adults. The neuro-imaging studies in violent adults have shown the existence of a unilateral loss of tissue in the amygdala and in the hippocampus of the temporal lobe, and a positive correlation between the reduction of the hippocampus bilateral size and the high scores in psychopathology scales has even been established (Mesa-Gresa and Moya-Albiol, 2011).

### *Alcohol consumption and other abuse substances*

In women, the most frequent reason for the crimes of murder and assault is the confrontation with the victim in combination with the use of alcohol (Weizmann-Henelius *et al.*, 2003). So it seems that there is a positive relation between alcohol consumption and the expression of disruptive behaviours such as violence (Hoaken, Campbell, Stewart and Phil, 2003). However, this kind of behaviours would be decreasing with age (Livingstone and Room, 2009). Furthermore, significant differences between men and women have not been described in the characteristics and prevalence rates of the delinquency associated with alcohol (Cooper, 2002; Vandiver, 2010).

It seems that alcohol would facilitate the expression of violence by its immediate stimulant effects that increase the search for sensation and impulsivity (Hoaken and Stewart, 2003). Moreover, alcohol consumption deteriorates attention, which would affect in turn cognitive processing. So the perception of the internal and external information is restricted in order to focus the conscious perception on a small number of outgoing stimuli and thus increase the probability to react in a violent way when neglecting part of the information (Romero-Martinez and Moya-Albiol, 2013).

Regarding the abuse of cocaine, some studies with animals have revealed an increase in the levels of maternal aggression after the administration of cocaine during gestation. It has been attributed to the effect of the cocaine in the levels of oxytocin in the post-partum period (Heyser, Molina and Spear, 1992; McMurray *et al.*, 2008). These studies have been replicated in humans, for those women that consumed cocaine during their pregnancy showed higher levels of aggression towards their babies in comparison with the mothers of the control group. Moreover, the relation between maternal consumption of cocaine and maternal aggression were mediated by the negative affect of the mother and the poor autonomic regulation of the baby (Eiden, Schuetze, Colder and Veira, 2011). Furthermore, it has been determined that in most cases these women not only consume cocaine, but also alcohol, tobacco and/or marijuana, which could increase the levels of maternal aggression (Dixon, Kurtz and Chin, 2008; Wakschlag and Hans, 2002), as well as the levels of aggressiveness in incarcerated women (Lewis, 2011).

The consumption of 3,4-methylenedioxymethamphetamine (MDMA) to an acute level bears a temporal increase of serotonin release (5-HT) that provokes a fostering in the attitudes of affiliation both in women and men. However, abstinence from MDMA produces a decrease of the 5-HT increasing the risk of aggressive and violent behaviours both in men and women (Verheyden, Hadfield, Calin and Curran, 2002). This fact is congruent with the hypothesis that human violence could be due to deficit levels of 5-HT (Moya-Albiol, 2010). On the other hand, differences in gender among MDMA consumers on a level of self-reported aggression four days before its consumption are not found

(Verheyden *et al.*, 2002). However, a study performed with consumers of phencyclidine, angel dust or MDMA revealed the existence of differences in gender related to the moment in which the aggressive behaviours appear. Whereas men showed them during the intoxication period, women did so between the periods of intoxication (Fishbein, 1996).

### *Biological correlates*

*The role of hormones, serotonin and dopamine.*- Positive correlations have been described between the levels of estradiol in blood and the degree of aggressive behaviour in women as well as with verbal and physical aggressiveness (Cutler Jr and Chrousos, 1981; Jnoff-Gormain, Arnold, Nottelman, Suman, Glaude, 1991; Leibenluft, Fiero and Rubinow, 1994). On the other hand, emotional and psychological changes that occur along the menstrual cycle have been linked to the changes in the criminal activity of women. Along the menstrual cycle variations in the levels of sexual steroids take place, which in some cases imply a positive correlation with the aggressive behaviour. In particular, this association has been described in the early follicular stage (days 7-8 of the cycle), in the midluteal stage (days 21-22 of the cycle) and in the premenstrual stage (days 26-27). However, not all research has found this association. Actually, the levels of global aggressiveness in healthy adult women did not vary significantly along the menstrual cycle, despite the changes observed in the secretion of estrogens and progesterone. Moreover, the variations in the levels of prolactin, which is a peptide hormone that has synergic effects with the estrogens, in women with fertility problems were not linked to variations in feelings of anger nor with its the expression (Barry *et al.*, 2014). However, positive correlations have been found between the concentration of estrogens and the verbal aggressiveness in the follicular stage and with the resentment in the luteal stage (Brambilla, Specca, Pacchiarotti and Biondi, 2010).

On the other hand, higher levels of testosterone in blood have been described in aggressive women (in different species) in contrast with those less aggressive (Ehlers, Richler and Hovey, 1980; Gil-Verona *et al.*, 2002) or those who are not (Banks and Dabbs, 1996). Those results were more pronounced in prisoners condemned by violent crimes without provocation, and less in women condemned by violent defensive crimes, such as killing their partner after experiencing several episodes of mistreatment (Mazur and Booth, 1998). Thus, testosterone seems to keep a positive relation with behaviours of aggressive domination in violent female delinquents, whose objective would be to assure the submission of the people around them (Dabbs and Hargrove, 1997). So the increases in this hormone would help reduce their fear of punishment and would increase the sensitivity for immediate reward (Van Honk, Schutter, Hermans, Putman, Tuiten and Koppeschaar, 2004). As with men, the levels of testosterone in women decrease with age (Vermeulen, 1976) in the same way as violence, as well as muscle

strength. Thus, a less aggressive behaviour has been described in older female inmates (Dabbs and Hargrove, 1997).

Recently it has been described that the morning levels of cortisol and adrenocorticotropic (ACTH) in the blood of filicide mothers staying in a penitentiary psychiatric hospital are higher than in non-violent control mothers. This could indicate a reduced sensibility of the adrenal glands to the ACTH, probably due to the long-term affective stress previous to the hospitalisation and the homicide of the child. Around four years after the homicide, even after a pharmacological treatment with antidepressants, those mothers kept presenting ACTH levels significantly higher than those who were not filicides, which could be related to the imbalance in the hypothalamic-pituitary-adrenal (HPA) axis. Normally, the treatment with antidepressants is associated with a restoration of the HPA axis equilibrium, which could explain why, despite the high percentage of cases of post-partum depression, only few women kill their children. However, the interaction with variables such as psychobiological vulnerability and the exposure to stress that would facilitate filicide behaviours would be necessary (Spironelli, Gradante, Gradante and Angrilli, 2013). In men, an inverse relation has been observed between aggressiveness and cortisol levels in the evening, so low levels of cortisol or a hypoactive HPA axis would not inhibit the production of testosterone. Thus, high levels of testosterone, through their action over several cognitive systems, would facilitate violent behaviour in men condemned for gender-based violence (Romero-Martínez, González-Bono, Lila and Moya-Albiol, 2013; Romero-Martínez, Lila, Sariñana-González, González-Bono and Moya-Albiol, 2013). However, this relation has not been proven in violent women. In the case of non-violent women, the cortisol awakening response (CAR), an indicator of the activity of the HPA axis, has been linked to aggression according to the phase of the menstrual cycle. Thus, verbal aggression modulates the CAR during the follicular stage, while anger and physical aggression modulate it during the luteal phase. This is why it has been argued that the CAR could be used as a reliable maker of predisposition towards aggressiveness, and it has to be considered differently according to gender and the stage of the menstrual cycle (Sariñana-González *et al.*, print).

As it has been pointed, several hormones such as estrogens, estradiol, testosterone and cortisol are related to aggressive behaviour in women. However, other hormones facilitate the behaviours of affiliation and attachment and thus are related, indirectly, to violence. In several mammal species, most of the nulliparous females avoid or even attack the newborns; however, they become affective mothers after the delivery. In the last months of gestation, as a response to the increase of the levels of estrogens, the oxytocin receptors are regulated upwards in the uterus and in the brain. The vaginal-cervical stimulation during the delivery gives rise to the activation of the oxytocin neurons in the hypothalamus, stimulating the release of oxytocin in several areas of

the brain, including the pre-optic area, the ventral tegmental area and the olfactory bulb. These central ways are critical for the coordination of the maternal behaviour including the nests construction or the caring for the babies in the nest (Campbell, 2008). Moreover, it has been observed that, under threat, the stress-enhanced oxytocin serves to calm the woman who is physiologically activated by stress, boosting an affiliative behaviour; in contrast to men, where testosterone induces aggressive behaviour (Moya-Albiol and Serano, 2009; Taylor *et al.*, 2000).

Finally, it has been observed that the reduction of serotonin through the technique of tryptophan reduction (administration of an amino acids beverage with a reduced proportion of tryptophan) in the late luteal stage increases the levels of aggression in healthy women (Bond, Wingrove and Critchlow, 2001), being the decline more pronounced in women than in men. Those women who had had the beverage with the reduced proportion of tryptophan showed higher levels of aggression in response to provocation. These results are consistent with scientific literature, for in broad terms, an inverse relation has been described between the basal levels of serotonin and aggressive and violent behaviour (Moya-Albiol, 2010). These low levels of serotonin with the excess of dopamine in the ventral prefrontal cortex would facilitate the expression of violence, specifically, the impulsive one. Furthermore, the consumption of abuse substances would be associated with impulsive violence due to an unbalanced regulation among these neurotransmitters (Seo, Patrick and Kennealy, 2008).

*The role of the psychophysiological variables.*- It has been stated that violent people would have an specific functioning of the Autonomous Nervous System (assessed by cardiovascular and electrodermal variables) that would make it possible to differentiate them from the non-violent population (Romero-Martínez, Lila, Williams, González-Bono and Moya-Albiol, 2013; Romero-Martínez, Nunes-Costa, Lila, González-Bono and Moya-Albiol, 2014). The proper functioning of this system is based on the equilibrium between the sympathetic and the parasympathetic nervous systems. So the predominance of one of them over the other could be a valid indicator about the predisposition towards violence. The sympathetic reactivity to stress has made it possible to differentiate two different kinds of violent people according to the type of violence performed. Firstly, we have the type I or those who act premeditatedly (in a proactive way). Those tend to show a low arousal to confront stress. On the other side, we found the type II, who react in an impulsive way and are more physiologically activated before the appearance of the stress, that is, those who would present a sympathetic predominance (Romero-Martínez *et al.*, 2013; 2014). Despite the fact that the major part of the research has been carried out with men, the studies with women have concluded the same results, for those who presented higher disguised proactive violence presented a low reactivity to stress, while those who did so in an impulsive way presented an hyper-

reactivity to stress (Murray-Close and Rellini, 2012). Another recent study has manifested that higher physical aggressiveness in girls is related to a higher reactivity to a laboratory stressor, while disguised aggressiveness is related to a lower reactivity to the before-mentioned stressor (Murray-Close *et al.*, 2014). However, in another current research carried out in girls with borderline traits, no significant relation was found between aggressiveness and electrodermal reactivity (Banny, Tseng, Murray-Close, Pitula and Crick, 2014). On the other hand, girls with psychopathic traits and predisposition towards violence are characterised by a low electrodermal activity in the conditioning of fear (Gao, Raine, Venables, Dawson and Mednick, 2010).

## Conclusions

Up to now, the lower prevalence of violence associated with delinquency in women as compared to men seemed to indicate that it was not necessary to understand nor intervene in order to prevent the criminal behaviours in them. As we have explained along this work, research focused on violence in women is scarce, particularly when carried out from an integrative perspective that includes biological markers along with other psychosocial aspects. However, the described results in the different studies are in contradiction with the tendency to think that women are not able to commit violent crimes. It has been proved that women are able to perform equal or crueller behaviours than men, even though the beginning and the reasons of such behaviours usually differ. Delinquency in women has experienced changes regarding the types of crimes committed, but if we try to draw the profile of women as murderers, we can conclude that their victims are usually male acquaintances, that they are looking for a reward and that the most common method is poisoning.

Female inmates constitute a population with complex medical and psychiatric needs and often use the services offered within the penitentiary system. The treatment of these women must be as individualised as possible, trying to structure different kinds of therapeutic communities. These programmes should emphasise abstinence and the development of competencies for engaging in healthy relations (Lewis, 2006). Moreover, several studies point out that the low self-esteem associated with victimisation should be a priority in the programmes of treatment with women (Shearer, 2003; Wilson, Attril and Nugent, 2003). Up to now, research about the effectiveness of the interventions with delinquent women has been scarce (De Vogel, Stam, Bouman, Ter Host and Lancel, 2014; McGlynn, Hahn and Hagan, 2012). The results obtained have showed that the interventions directed towards the reduction of the cognitive distortions not only improve their cognitions and their behaviour, but also reduce their incidence (Lipsey, Wilson and Cothorn, 200; Wormith *et al.*, 2007).

In reality, the problem of criminality in women is more complex than it would seem *a priori*, for women could be at

the same time both victims and victimisers. The main risk factors for the beginning of criminality in women are usually the experiences of abuse and mistreatment during childhood. This kind of victimisation increases the possibilities that these girls, both psychologically and biologically, are more prone to delinquency. Thus we find a decrease in the hippocampal and corpus callosum volume in mistreated girls, as well as a hyper-responsiveness of the amygdala. Furthermore, the consumption of substances and their effects in the brain has been linked to the performance of violent crimes in women. Thus, a positive association has been found between aggressive behaviour and the consumption of alcohol, cocaine, MDMA and phencyclidine.

From a psychobiological perspective, the relation between high levels of cortisol, ACHT or testosterone and aggressive behaviour in women must be highlighted, as well as the correlation with low levels of serotonin. On the contrary, the boosting function in affiliative behaviour that oxytocin has in the behaviour of women must be also pointed out. So, some specific aspects of aggressiveness could have a tighter relation with hormonal changes in women than the aggressiveness considered globally. Regarding the role of the Autonomous Nervous System, the same previous categorisation made with men is valid in the case of women. However, more research in this topic is needed, for it is scarce.

From all the above, it would be necessary to consider the preservation of their physical safety and a healthy development to reach the prevention of violence in women. Prevention programmes could be focused on the optimisation of the girls' life conditions in contexts of social exclusion, poverty or violence, trying to prevent violent experiences in their homes or sexual abuses by their relatives, as well as providing them with resources against the consumption of substances or the use of violence as strategies to face problems.

The need to carry out more research about violence in women is evident, fundamentally from a neurobiological and integrated perspective that includes biological markers along with other psychosocial aspects, for it has been assumed implicitly that the data obtained with male samples were extrapolated to the entire population. All this would allow the establishment of neurocriminal profiles that include biological markers along with some other psychological and social markers, which would contribute to optimise the diagnosis, the treatment and the prevention of the violence in this population. Moreover, this research would help to create new prevention programmes, as well as treatment programmes addressed specifically to violent women.

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