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Reduced salivary oxytocin after an empathic induction task in Intimate Partner Violence perpetrators: Importance of socio-affective functions and its impact on prosocial behavior

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ABSTRACT

Intimate Partner Violence (IPV) has been linked to difficulties in socio-affective functions. Nevertheless, the underlying psychobiological mechanisms that might be responsible for them remain unclear. Oxytocin (OXT) stands out as an important hormone that may favor the salience of social information, due to its relevance in empathy and prosocial behavior. Thus, the study of salivary OXT (sOXT) may provide further information about potential impairments in social cognition in IPV perpetrators. This study analyzed the effects of an empathic induction task, performed through negative emotion-eliciting videos, on endogenous sOXT levels, mood state, and emotional perception in 30 IPV perpetrators compared to 32 controls. Additionally, we explored their performance on prosocial behavior after the empathic induction task, using Hare's donation procedure. Lower sOXT levels were found in IPV perpetrators after the task compared to controls, along with a general decreasing tendency in their sOXT levels. Additionally, IPV perpetrators exhibited no change in their mood state and perceived others' emotions as more positive and less intense. Moreover, the mood state response and alexithymia traits, respectively, positively and negatively predicted the sOXT levels after the empathic induction task in the entire sample. Finally, we did not observe a lower appearance of prosocial behaviors in IPV perpetrators; however, higher sOXT levels after the empathic induction task were found in subjects who donated when considering the whole sample. In sum, IPV perpetrators exhibited differences in their sOXT levels when empathizing, compared to controls, with alexithymia and the emotional response potentially explaining the sOXT levels after the task. Furthermore, prosocial behavior was more related to these sOXT levels than to IPV. As our knowledge about the emotional processing of IPV perpetrators increases, we will be better able to develop and include coadjutant treatments in current psychotherapeutic programs, in order to focus on their emotional needs, which, in turn, would reduce the future risk of recidivism.

1. Introduction

Intimate partner violence (IPV), defined as any act that results or may result in physical, sexual, or psychological harm to women in heterosexual relationships (World Health Organization, 2019), has emerged as a serious public health problem with high social, economic, and human costs (Vilariño and Arce, 2018). Research has focused on addressing IPV characteristics in order to develop comprehensive and effective intervention programs to prevent this type of violence (Santirso et al., 2020). For this purpose, the Biopsychosocial Model is an important explanatory approach that views IPV as a multi-causal variable and highlights the relevance of integrating psychosocial, affective, and biological aspects (Pinto et al., 2010), incorporating neuroscience methodology into models focused on psychosocial factors (Kelly and Wilson, 2020).

Impairments in socio-affective functions have recently been identified as an important factor in IPV (Brem et al., 2018; Romero-Martínez et al., 2013), with many IPV perpetrators showing difficulties in

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identifying, describing, and/or expressing their own and others' feelings, deficits that are defined as alexithymia (Romero-Martínez et al., 2020). This construct has been directly implicated in difficulties in social cognition processing, specifically in recognizing others' emotions (Di Tella et al., 2020; Romero-Martínez et al., 2019c). This inability to recognize and/or regulate emotional inner states might underlie poor understanding of others' thoughts and emotions (perspective taking) (Grynberg et al., 2010; Lyvers et al., 2018). This impaired processing of socio-affective stimuli could result in difficulties in responding to or sharing emotions with others, as well as considerable affective distress when dealing with social interactions, which would make them feel overwhelmed (Finkel and Hall, 2018; Leshem et al., 2019; Strickland et al., 2017). Therefore, these serious difficulties have been pointed out as mechanisms that partially explain the reduction in adaptive social functioning and the risk of IPV maintenance and recidivism (Romero-Martínez et al., 2016a, 2019b, 2019d).

From the Biopsychosocial Model perspective, the hypothalamic neuropeptide oxytocin (OXT) could be of special interest for the study of IPV because it plays an important role in social cognition (Patin and Hurlemann, 2015). Particularly, OXT has been linked to the salience of socio-affective information, facilitating emotional decoding processes and the mediation of social reward sensitivity, processes that may be relevant for functions such as empathy, bonding, and prosocial behavior (Crespi, 2016; Shamay-Tsoory and Abu-Akel, 2016). Research in this field has focused on the study of the relationship between endogenous basal levels of OXT and psychological traits that are important for social cognition and empathy, or it has examined the behavioral effects of intranasal administration of OXT (Geng et al., 2018; Hurlemann and Grinevich, 2018). However, several authors have highlighted the importance of complementing this research with the study of endogenous OXT levels in response to socio-affective stimuli (Hurlemann and Grinevich, 2018). These authors emphasize the importance of research with naturally induced approaches that favor a more realistic understanding of the relationship between empathy and OXT, such as the study of the endogenous OXT response to empathic induction tasks. In a first study, Barraza and Zak (2009) showed an increase in endogenous plasma OXT (pOXT) levels in a sample of college students (52% women) after watching a video with high emotional content of people in distress. They also observed a positive relationship between pOXT and the degree of empathy experienced, measured by the increase in their mood state. This result was reproduced in another study on endogenous salivary OXT (sOXT) that also showed an increase in sOXT levels after exposure to the same empathic induction task (Procyshyn et al., 2020) in a similar sample of college students (54% women).

In addition, sOXT has also been implicated in prosocial behaviors through the strengthening of trust and helping behaviors (Hurlemann and Marsh, 2016). Marsh et al. (2015) found a relationship between prosocial behavior and changes in endogenous sOXT. In their study, they found that male and female students who anonymously donated part of their experimental retribution to social charities had an increase in their sOXT levels. Moreover, Barraza and Zak (2009) reported that participants who had a greater response to an empathic induction task, measured by increased pOXT and positive mood state response, donated more money to social charities. These findings led to the idea that interpersonal relationships involving prosocial behavior could be significantly modulated by sOXT through the empathic function.

However, the effect of OXT on social cognition can differ substantially, with some authors establishing a complex pattern where the social context and individual differences moderate both central and peripheral OXT release (DeWall et al., 2014). Specifically, research suggests that highly aggressive men differ from the general population with respect to their OXT system, linking lower OXT levels in this population to deficits in socio-affective functions (Demirci et al., 2016; Levy et al., 2015). Unfortunately, these studies did not assess group differences in baseline OXT levels. Even though a previous study failed to report baseline sOXT level differences between IPV perpetrators and controls (Romero-Martínez et al., 2021), they did not assess whether baseline sOXT levels were related to socio-affective alterations (e.g., alexithymia, empathy, prosocial behavior…) in IPV perpetrators. However, to the best of our knowledge, there are no studies that have considered the influence of these socio-affective difficulties in the sOXT response to an empathic induction task in both IPV perpetrators and in non-violent men.

Therefore, the main objective of this study was fourfold. First, this study aimed to analyze whether there are differences between IPV perpetrators and controls in their baseline sOXT levels and alexithymia traits. We first hypothesized that, in line with previous research (Hurlemann and Grinevich, 2018; Romero-Martínez et al., 2019c, 2021), the groups would not differ in their baseline sOXT levels. Moreover, we also expected that IPV perpetrators would present higher alexithymia traits than controls. Second, we also aimed to assess whether there are differences between IPV perpetrators and controls on their endogenous sOXT levels and negative mood state in response to an empathic induction task. Accordingly, prior literature has found increases in endogenous sOXT and negative mood state following an empathic induction task in a normative population (Barraza and Zak, 2009; Procyshyn et al., 2020). Nonetheless, IPV perpetrators tend to present important alterations in perceiving the affective state of others and higher alexithymia traits (Romero-Martínez et al., 2016a, 2019c, 2020). Therefore, we hypothesized that IPV perpetrators would present a buffered sOXT response. Conversely, we expected an increase in sOXT levels and a worsening of mood after the task in controls.

Third, we also aimed to explore whether negative mood state, emotional perception after the emotion induction task, and/or alexithymia predict sOXT changes in response to the task. Based on previous conclusions in this field (Hurlemann and Grinevich, 2018; Romero-Martínez et al., 2016a, 2019b, 2020; Shamay-Tsoory and Abu-Akel, 2016), we would expect low emotional perception and high alexithymia traits to predict the buffered sOXT response in IPV perpetrators, whereas high emotional perception and worse mood would predict sOXT changes in controls.

Four, we also investigated the difference in the performance of prosocial behavior between IPV and controls, as well as the difference in the sOXT levels after the task between those who perform prosocial behavior and those who do not. We expected a greater sOXT response in the prosocial subjects, independently of whether they were IPV perpetrators or not (Marsh et al., 2015).

2. Methods

2.1. Participants

From an initial total sample of 66 participants, two IPV perpetrators and two controls were excluded from the study because their sOXT levels exceeded the standard deviation of the total sample by 2.5 or more. The final sample consisted of 62 healthy male volunteers (30 IPV perpetrators and 32 controls). The IPV perpetrators were recruited from the participants in the CONTEXTO Program, a community-based psychoeducational intervention program that is mandatory for men convicted of gender-based violence. The study was carried out at the Department of Social Psychology at the University of Valencia prior to the start of the intervention.

The IPV perpetrators were required to have a sentence for gender-based violence that had been suspended on the condition that they attend an intervention program (Lila et al., 2018). They had to be free of any mental and/or neurological disorders, not have consumed substances for at least two hours before the study and have good writing and speaking skills in Spanish. The assessment of the IPV perpetrators' history of violence was based on information provided by judicial and probation system professionals (e.g., previous violence against other people", physical, psychological, and/or sexual IPV perpetration, criminal previous records…), as well as information provided by the participant. Furthermore, participants also completed the Conflict Tactic Scale 2 (CTS-2) (Straus et al., 1996) validated in Spanish (Muñoz-Rivas et al., 2007) during individual interviews. Our sample included participants with episodes of physical and/or psychological violence.

The control group was composed of volunteers who presented similar anthropometric (age, and/or body mass index) and socio-demographic (age, educational level, annual income, and/or marital status) characteristics to those of the IPV perpetrators, in addition to not having any previous criminal record. Additionally, they had to score below 1 on the CTS-2 (Muñoz-Rivas et al., 2007; Straus et al., 1996). They were recruited in Valencia (Spain), and contact was made through advertisements posted on social networks. The participants were selected after performing an individualized phone interview. Prior to the experimental phase, each participant was interviewed by two clinical psychologists trained in the treatment of IPV to screen for psychopathology and/or personality disorders. Inter-rater agreement between the two qualitative interviewers had to be above.80 for the psychopathological and personality dimensions evaluated. All participants were informed about the study, voluntarily agreed to participate, gave their written informed consent, and received a financial retribution of 40 euros at the end of the study.

The experiment was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the University of Valencia (procedure number: H1538385543901).

2.2. Procedure

The procedure was carried out in one experimental session in the Psychobiology laboratories at the University of Valencia, where a constant temperature (21ºC) and humidity were maintained. The session always took place between 4:00 and 7:00 p.m. with an approximate duration of 2 h. First, the informed consent was signed, and the anthropometric were measurements taken. Then, the first questionnaires on the participants' mood state were completed (baseline), and baseline sOXT was collected. Next, the participants were introduced to the empathic induction task, and anticipatory sOXT was taken.

Following the guidelines of Procyshyn et al. (2020), the empathic induction task consisted of watching a battery of emotion-eliciting videos validated for the Spanish population (PIE) (Fernández-Megías et al., 2011). Before watching, the participants were told to actively empathize with the main character of each scene (previously singled out), and they were informed that they had to complete a questionnaire reporting the perceived emotional response of the characters. Four scenes (averaging 1' 21") were selected from the battery based on their high arousal and negative affect (see Table 1). The selection of these scenes was based on the recommendations proposed in Gracia et al. (2015) and Romero-Martínez et al. (2019a, 2019b, 2019c, 2019d, 2019e). These studies pointed to the existence of alterations in the processing of socio-cognitive and emotional stimuli in IPV perpetrators when processing clips with specifically IPV content. Thus, we selected two scenes where male characters received violence and two scenes where violence was received by female characters. Each participant performed the empathic induction task, watching the scenes on a 75'' screen. Following guidelines from previous studies (Schaefer et al., 2010), participants were asked to relax for one minute before watching each scene, and they had to complete the questionnaires right after every scene.

Table 1
Selected scenes for the empathic induction task.

Film	Description	Length	Valence	Arousal
Leaving Las Vegas	A female character is sexually assaulted in a motel	2´	1,73	5,64
The Piano	A pianist's hand is cut off with an axe	0´46´´	2,36	6,09
Schindler's List	A concentration camp commander shoots at prisoners from his balcony	1´16´´	1,55	5,73
American History X	A neo-Nazi kills a man	1´20´´	1,82	6,58

Note: Video clips are from the battery of films with emotion-inducing capacity validated for the Spanish population (Fernández-Megías et al., 2011). Valence was measured from 1 (negative valence) to 10 (positive valence). Arousal was measured from 1 (low arousal) to 10 (high arousal).

After the empathic induction task was over, post-empathic sOXT was collected, the mood state questionnaire was filled out again, and the participants went through a recovery phase divided into three 20-minute periods in which the following three sOXT samples were collected: post 20', post 40', and post 60', respectively. During the recovery period, questionnaires were completed to collect information on socio-demographic variables, alexithymia, and alcohol consumption.

Finally, once the recovery period had ended, the mood state questionnaire was filled out again, and a prosocial laboratory task was performed that consisted of making a charitable donation, replicating the Hare et al. (2010) assessment procedure. The suitability of this task (e.g., charitable donations) for measuring altruism-motivated prosocial behavior in normative populations has been shown (Böckler et al., 2016; Huang et al., 2021; Tusche et al., 2016; Waytz et al., 2012). Furthermore, the occurrence of these prosocial behaviors has been related to a greater response to an empathic induction task in a normative population (Tusche et al., 2016), suggesting that individuals with more prosocial behaviors appear to exhibit a greater propensity for empathizing. The procedure was divided into three phases: (1) taking perspective of a context where a problem is presented, (2) evaluating the participant's potential impact on the resolution of the problem, and (3) an opportunity to perform a helping behavior. First, we presented informative documents about six Non-Governmental Organizations (NGO). Then, the participants were asked to assess the extent to which each NGO deserved help. To monitor the effect of possible personal contact with the organizations, the degree of closeness to the NGO was assessed on a 3-point Likert scale (1 - no closeness; 3 - active participation in the organization). Finally, participants were given the opportunity to help the NGO by means of a donation, emphasizing the voluntary nature of the donation. Once the donation had been proposed, the participants had to write down in a document the amount donated and the NGO that received the donation. To reduce a possible bias due to social desirability, the experimenters left the room while the participant decided whether to make the donation. As a result, the participants were divided into donors (participants who had donated at least 50% of their financial retribution) and non-donors. The donation was taken from the economic retribution the participants received. Once the prosocial laboratory task had ended, they were informed that they would receive the full remuneration. At the end, the participants were escorted out of the laboratory and dismissed. (Fig. 1).

2.3. Measures

To measure mood, the reduced version of the "Profile of Mood States" (POMS), adapted to the Spanish population, was used (Fuentes et al., 1995; McNair et al., 1971). This version has 29 items with a total score indicating negative mood. The response format is a five-category Likert scale with values between 0 (none) and 4 (very much). A total score was calculated by adding all the negative scales (tension, depression, anger, vigor, and fatigue) and subtracting vigor. Cronbach's α was.83 for the total score.

To measure perceived emotional state in others, the Self-Assessment Manikins (SAM) (Bradley and Lang, 1994) was used. The SAM evaluates the affective valence (SAM-Val), which ranges from 9 (positive valence) to 1 (negative valence), and arousal or activation (SAM-Act), which ranges from 9 (high arousal) to 1 (low arousal). Each subscale is represented by 5 graphic figures with 4 intermediate points, making up the

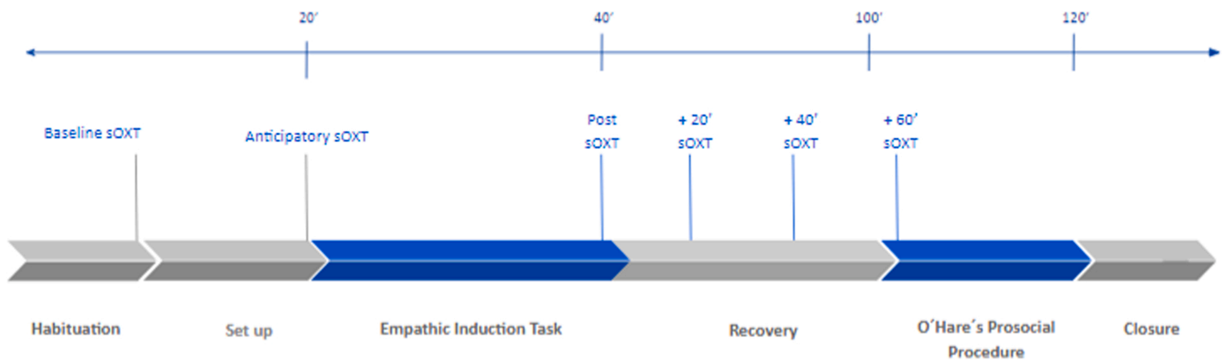

Fig. 1. Experimental procedure.

9-point scale. This questionnaire was used to measure the participant's perception and understanding of the characters' emotional state in the scenes, which is an indicator of cognitive empathy. Cronbach's α was.68 for the total score.

The "Toronto Alexithymia Scale - 20 items" (TAS-20; Bagby et al., 1994) was used to measure the trait of alexithymia. The TAS-20 is a widely used self-report measure that has demonstrated adequate reliability and validity in its original version and in the Spanish adaptation (Martínez-Sánchez, 1996) used in the present study. The TAS-20 contains 20 items with a response system based on a 5-point Likert scale ranging from 0 (strongly disagree) to 6 (strongly agree). Cronbach's α was.80.

The Spanish version (Guillamón et al., 1999) of the "Alcohol Use Disorder Identification Test" (AUDIT) (Saunders et al., 1993) was used to verify the amount and frequency of alcohol consumption in adults. Cronbach's alpha was.85.

2.4. sOXT levels

To collect the oxytocin levels, we took saliva samples from the participants directly from the mouth using Salivettes (Sarstedt, Rommersdolf, Germany). Six saliva samples were collected as follows: (1) baseline measurement, (2) anticipatory measurement of empathic induction, (3) post-empathic induction measurement, and (4) three measures during the recovery period (after 20, 40, and 60 min). The saliva samples were frozen at − 20 °C immediately after collection and kept in this state until analysis in the laboratory. Saliva samples were initially lyophilized (Modulyo Freeze Dryers, Thermo Electron Corporation) for approximately 15 h until they were dehydrated (Daughters et al., 2015). Following the manufacturer's instruction for centrifugation, the samples were centrifuged 5 min × 1000 g and then, from each saliva sample, 1 ml of supernatant was stored and frozen at − 40 °C. Then, these samples were reconstituted in 250 μl of assay buffer, which produced a concentration four times higher than the original. The result of this extraction procedure ensured that simple concentrations within the assay were above the assay sensitivity level and detectable on the linear portion of the standard curve (Carter et al., 2007). The sOXT levels were measured using the commercial Oxytocin EIA kit (Arbor Assays, Inc. Ann Arbor, MI; ref: K048). We followed the procedure described in previous studies from our laboratory (for a detailed description, see Bellosta-Batalla et al., 2020a, 2020b; Romero-Martínez et al., 2021) and others (Lebowitz et al., 2016; MacLean et al., 2018). Remarkably, sOXT has been observed to correlate better than pOXT with concentrations in the cerebrospinal fluid (Martin et al., 2018). Neuropeptide cross-reactivity was reported by Arbor assays as < 0.001% and the detection limit was 11 pg. / ml. Saliva samples were read at 450 nm, and all samples were tested in duplicate. Inter-trial and inter-trial CV averaged less than 10%.

2.5. Data analysis

After evaluating the normality of the data with the Shapiro-Wilk test ($p < .05$), the non-normal data were transformed based on a Nephemerian logarithm (logn). A Chi square was performed to compare socio-demographic data (marital status, education level, and annual income), with the "group" variable (IPV perpetrators and controls) as an inter-subject factor. Additionally, independent means comparison *t*-tests were performed, with the "group" variable as an inter-subject factor for anthropometric data, alcohol use, alexithymia, SAM scores, and baseline sOXT.

To analyze the possible change in sOXT levels, repeated-measures ANOVAs were performed with the variable "time" (baseline, anticipatory, post-empathic task, and recovery) as the intra-subject factor, and "group" as the inter-subject factor. Greenhouse-Geisser corrections for degrees of freedom were applied where appropriate. For significant results, partial eta-square was reported as a measure of effect size. Comparison *t*-tests were also performed for the magnitude of the sOXT levels, with "group" as an inter-subject factor. The magnitude of the sOXT levels was estimated for the empathic induction task by calculating the area under the curve with respect to the ground (AUCg), considering the baseline, anticipatory, post-empathic task, and recovery measures. The magnitude of sOXT change with respect to the baseline was estimated by calculating the area under the curve with respect to the increase (AUCi). For the calculation of the AUCg and the AUCi, we used formulas derived from the trapezoidal rule, with AUCg collecting the entire area and AUCi taking the baseline as the reference point (Pruessner et al., 2003).

To analyze the possible change in mood state, a repeated-measures ANOVA was used for repeated measurements with the variable "time" (pre- and post-empathic task and recovery) as the intra-subject factor and "group" as the inter-subject factor. Greenhouse-Geisser corrections for degrees of freedom were applied where appropriate. For significant results, partial eta-square was reported as a measure of effect size. Additionally, the change score was measured as the difference between the post-empathic induction task and baseline. Group differences were calculated by employing *t*-tests. Pearson's correlation coefficients were calculated to assess the relationships between the psychological variables (change score for the negative mood state response, emotional perception, and alexithymia) and sOXT AUCg and AUCi. Finally, a multiple linear regression model was constructed using the significant variables from Pearson's correlation as the independent variables and the magnitude of the sOXT levels (measured by AUCg) and/or the magnitude of the sOXT response (measured by AUCi) as the dependent variables.

Additionally, a comparison of means was performed by using a two-factor Analysis of Variance (ANOVA), with the variables "group" and "donation" (donors vs no donors) as fixed factors and the AUCg and AUCi as the dependent variables. The observed power and effect size were also estimated.

Data analyses were conducted using IBM SPSS Statistics for

Windows, Version 22.0 (Armonk, NY). Values of $p < .05$ were considered statistically significant. The average values are reported in the tables as mean ± SE.

3. Results

3.1. Participant characteristics

There were no significant differences between IPV perpetrators and controls in demographic variables, anthropometric characteristics, and/or alcohol consumption. Nevertheless, the former presented higher scores on alexithymia (see Table 2).

3.2. Emotional perception scores

With regard to the SAM scores, IPV perpetrators perceived the characters with a lower affective arousal (t (42.8) = −2.11, p = .041) and a more positive valence (t (33.8) = 2.16, p = .038) than controls.

3.3. sOXT response to the empathic laboratory task

After checking that there were no significant differences between groups in sOXT baseline levels (t (52, 5) = 1.114, p = .258), the analysis did not find a significant "time" effect (F (5, 300) = 0.527, p = .756, η2p = .009) for the whole sample. Nevertheless, a significant "time x group" effect was found [F (5, 300) = 2.242, p = .048, η2p = .036], with IPV perpetrators only showing lower levels of sOXT than controls 40 min after the post-empathic induction task (IPV perpetrators, M = 4.42, SE =0.91; control group, M = 4.90, SE =0.55; t (46.8) = −2.48, p = .017) (see Fig. 2).

Additionally, IPV perpetrators differed in the magnitude of the sOXT response (AUCi) compared to controls (IPV perpetrators, M = −16.75, SE = 60.84; control group, M = 18.63, SE = 68.05; t (60) = −2.15, p = .035), with IPV perpetrators presenting lower sOXT AUCi than controls. However, the two groups did not differ in the total magnitude of the sOXT levels (AUCg) (IPV perpetrators M = 462.35, SE = 53.61; control group, M = 474.19, SE = 35.99; t (50.3) = −1.01, p = .315).

Table 2
Means, standard deviations, percentages, and means comparisons for socio-demographic and psychological variables for all groups.

	IPV ($n = 30$)	Controls ($n = 32$)	*t*-test independent samples
Age (*M, SD*)	39.63 (10.27)	37.66 (13.37)	-0.99
BMI (*M, SD*)	26.40 (6.25)	25.38 (2.83)	- 1.58
Alcohol consumption (*M, SD*)	7.43 (8.40)	5.64 (4.25)	1.02
Alexithymia (*M, SD*)	40.83 (17.96)	29.34 (12.99)	2.87 * *
			Chi-Square
Prosocial Behavior (%)			.89
Donation	23	19	
No donation	77	81	
Marital status (%)			.70
Married	53	50	
Single/Divorced/Widowed	47	50	
Level of education (%)			4.68
No studies	3	0	
Primary	40	28	
Upper secondary/vocational training	43	38	
University	14	34	
Annual Income (%)			1.53
Low Income	37	25	
Medium Income	53	56	
High Income	10	19	

Note: IPV: Intimate Partner Violence; Statistical significance *p < .05, **p < .01

3.4. Mood state response to the empathic induction task

With regard to mood state, a significant "time" effect (ε = 0.737, F (1.5, 87.7) = 12.990, p = .000, η^2_p = .178) was found. Specifically, the mood state total score increased significantly from baseline to the post-empathic induction task (M = 99.95, SE = 15.9; M = 106.11, SE = 16.5, t (61) = −3.455, p = .001). Afterwards, the mood state total score decreased again from the post-empathic induction task levels to the 60' recovery period (M = 106.11, SE = 16.5; M = 98.1, SE = 15.64, t (61) = −3.893, p = .000). Furthermore, there was a significant "time × group" effect (ε = 0.737, F (1.5, 87.7) = 7.159, p = .001, η^2_p = .107), with IPV perpetrators showing low negative mood state after the empathic induction task compared to the control group (M = 101.5, SE = 14.46; M = 110.4, SE = 17.36, t (61) = −2.179, p = .033) (Fig. 3).

Regarding change scores (post-empathic induction task minus baseline), IPV perpetrators also differed in the mood state response to the empathic induction task compared to controls (IPV perpetrators, M =0.83, SE = 13.28; control group, M = 11.16, SE = 13.03; t (60) = −3.08, p = .003), with IPV perpetrators presenting smaller changes in negative mood state than controls.

3.5. Relationships between the psychological variables and sOXT levels

With regard to the relationship between the psychological variables and sOXT, after controlling the group effect, partial correlation analysis showed that there were no significant correlations between the negative mood state response (r = 0.073, p = .578), the perceived character's affective valence (r = −0.062, p = .635), the perceived character's affective arousal (r = 0.014, p = 914), or the TAS-20 scores (r = −0.076, p = .561) and the sOXT AUCi levels. Nevertheless, the mood state response (r = 0.289, p = .024), the perceived character's affective arousal (r = 0.278, p = .030), and the TAS-20 total score (r = −0.348, p = .006) correlated significantly with the sOXT AUCg levels for the whole sample, but not with the perceived character's affective valence (r = 0.079, p = .543).

3.6. Predictive effects of the psychological variables on sOXT levels after the empathic laboratory task

We carried out a linear regression model with the negative mood state response (change score), the perceived character's affective arousal, and the total score on the TAS-20 as predictors of sOXT AUCg. As a result, the model predicted 21.9% of the sOXT AUCg after the empathic induction task (adj R^2 =.219, F (3, 61) = 6.700, p = .001). The association was significant for the negative mood state response (β = 0.305, p = .010) and alexithymia (β = −0.369, p = .003). Specifically, the higher the change in the negative mood state response and the lower the alexithymia traits, the higher the levels of sOXT. However, no significant association was found for perceived affective character arousal (β = 0.134, p = .262).

3.7. Prosocial behavior and response to the empathic laboratory task

Finally, despite not finding a significant main effect of "group" on the AUCg [F (1, 62) = 0.590, p = .446, η^2_p = .010] or "group × donation" [F (1, 62) = 0.000, p = .992, η^2_p = .000], we did find a significant main effect of "donation" on the AUCg of the sOXT levels [F (1, 62) = 6.239, η^2_p = .015, n = 0.097]. Thus, donors showed higher sOXT AUCg levels after the empathic induction task compared to non-donors (Donors, M = 510.32, SE = 43.77; and non-donors, M = 463.97, SE = 43.57; t (60) = 2.475, p = .015).

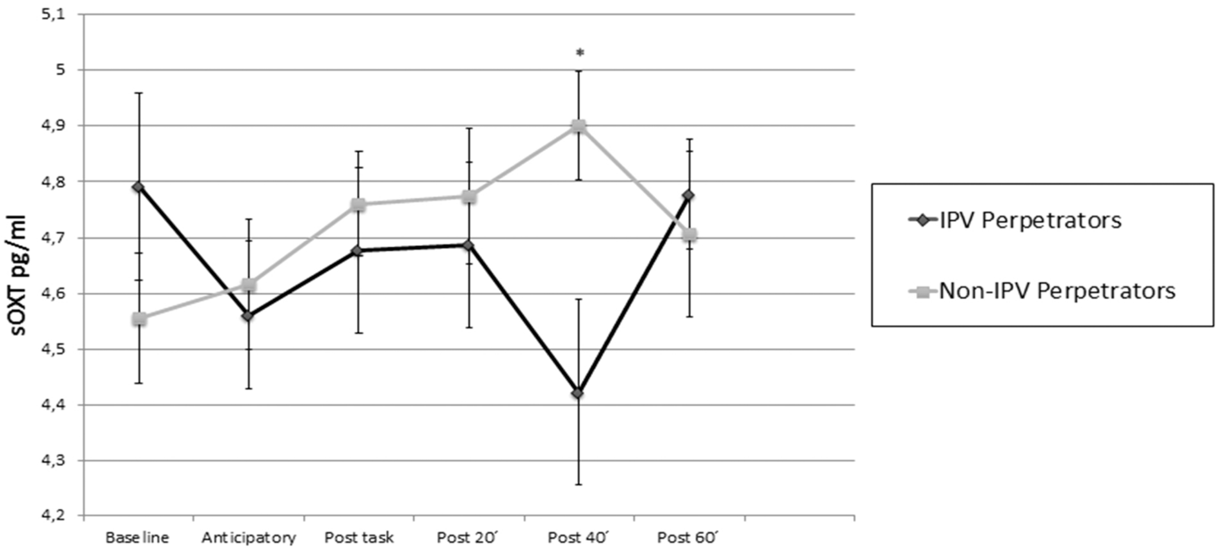

Fig. 2. sOXT response to the empathic induction task. ***Note:*** IPV: Intimate Partner Violence; Statistical significance *p < .05, * *p < .01.

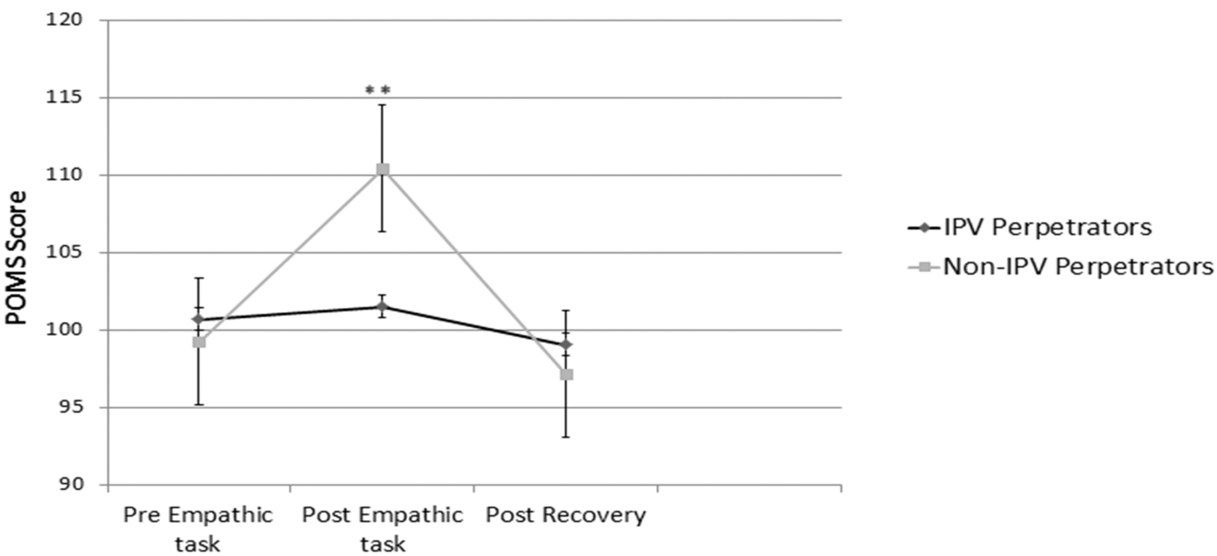

Fig. 3. Mood state response to the empathic induction task. ***Note:*** IPV: Intimate Partner Violence; Statistical significance *p < .05, * *p < .01.

4. Discussion

4.1. Discussion of the main results

Our study revealed differences in the sOXT response of IPV perpetrators to an empathic induction task compared to a control group, showing lower sOXT levels specifically 40 min after the empathic induction task, with a decreasing tendency in their sOXT levels after the task (AUCi). IPV perpetrators also perceived others' emotions as more positive and less intense and exhibited no change in their mood state after the task. For the whole sample, we observed a positive relationship between the AUCg of sOXT levels and the mood state response and perceived affective arousal, and a negative relationship with alexithymia. Afterwards, the regression model showed that the mood state response and alexithymia also predicted the AUCg of sOXT levels for the whole sample. Finally, we did not observe any differences in performing prosocial behaviors between IPV perpetrators and controls. However, a univariate ANOVA indicated that a greater AUCg of sOXT levels was found after the empathic induction task in subjects who engaged in prosocial behavior.

The first main objective of this study was to analyze whether IPV perpetrators and controls differ on baseline sOXT levels and alexithymia traits. As we expected based on previous literature (Hurlemann and Grinevich, 2018; Romero-Martínez et al., 2019c, 2021), the groups did not differ on their baseline sOXT levels, but IPV perpetrators presented higher alexithymia than controls. It is also relevant to note that, contrary to our expectations, IPV perpetrators seemed to exhibit higher baseline sOXT levels than the control group, although the results were not statistically significant.

The second objective of this study was to analyze whether the sOXT response of IPV perpetrators to an empathic induction task differed from the response of the control group. Past research has related higher sOXT levels to enhanced social cognition, and evidence has been provided for an increase in sOXT following an empathic induction task in normative populations (Barraza and Zak, 2009; Procyshyn et al., 2020). However, difficulties with socio-affective functions and lower sOXT levels have been suggested in men with aggressive behaviors (Demirci et al., 2016; Levy et al., 2015). Thus, we expected an increase in sOXT levels throughout the sample in response to the task, but this increase would be attenuated in the case of IPV perpetrators. Contrary to our expectations, there was no response in any of the sOXT levels when we considered the entire sample. Nevertheless, we observed an increase in sOXT levels from the pre-task periods to 40 min after the task only in the control group, and we found lower sOXT levels 40 min after the task in IPV perpetrators compared to controls. Furthermore, we observed a decreasing trend in the AUCi from baseline to 60 min after the empathic induction task in IPV perpetrators, in contrast to the control group, which exhibited an increasing tendency.

Prior research has proposed that humans with aggressive behaviors differ from healthy young adults with respect to their sOXT system (Hurlemann and Grinevich, 2018). It has been hypothesized that reduced peripheral and central OXT levels (which may reflect a "hypo-oxytocinergic state") could be related to and even predict aggression due to difficulties in processing socio-affective information (Malik et al., 2012). Our results could suggest a lack of sOXT response after an empathic induction task in IPV perpetrators, given that the control group showed an increase, albeit subtle, in their sOXT levels 40 min after the task, with an increasing trend, whereas it was decreasing in IPV perpetrators. This peak value of sOXT after exposure to an empathic induction task seems congruent with previous studies in this field. In this regard, the use of different laboratory tasks (e.g., to running, sexual self-stimulation, breastfeeding, video-exposure, among others) in normative populations revealed a maximum peak in sOXT from 15 to 90 min after these tasks (de Jong et al., 2015; Ooishi et al., 2017; Procyshyn et al., 2020). However, another study pointed out an immediate change in pOXT levels after exposure to video content (Barraza and Zak, 2009). Moreover, Procyshyn et al. (2020) also found an immediate increase in sOXT after video exposure, and so further research is needed to clarify the variations in sOXT in response to specific tasks. Notably, IPV perpetrators showed higher basal sOXT levels. Indeed, a growing number of studies have indicated that high OXT levels may activate negative cognitions in individuals with an anxious attachment style (Bartz et al., 2010), a predominant attachment style in IPV perpetrators (Genest and Mathieu, 2014). In this regard, Levy et al. (2015) found that an anxious attachment style was more related to a fight or flight model, broadly related to aggression, rather than a "tend-and-befriend" model, an OXT-based model related to empathic responses in times of elevated distress (Taylor et al., 2000). Therefore, although these results should be viewed with caution, they do not run counter to the "hypo-oxytocinergic state hypothesis" in the violent population (Hurlemann and Grinevich, 2018). In fact, they may point to a possible hypo-oxytocinergic response to important socio-affective functions of social cognition, such as empathy, in this population.

Additionally, we sought to explore the participants' negative mood state response to the empathic induction task, as well as their capacity to perceive other people's emotions. IPV perpetrators have previously been linked to difficulties in emotional perspective taking and higher personal distress (Covell et al., 2007). Therefore, we expected them to exhibit a diminished affective and cognitive approach to the character's emotional state. Congruently, IPV perpetrators did not show any change in their mood state from pre-task to post-task mood state total scores, unlike the control group, which exhibited worse mood comparable to the character's emotional state. Furthermore, IPV perpetrators also rated the character's emotional state as less intense and with higher positive affect than the control group.

Past research has suggested that specific alterations in the ability to decode and experience emotions may make IPV perpetrators prone to domestic violence (Romero-Martínez et al., 2019c). In this regard, IPV perpetrators have been seen to exhibit a different pattern of emotional processing, displaying lower activation when they were required to experience emotions in situations of IPV (Marín-Morales et al., 2021). In line with these studies, our findings may reflect a poor affective approach to the characters' emotional states (Barraza and Zak, 2009), suggesting difficulties when responding to the feelings of others (Marín-Morales et al., 2021). Additionally, IPV perpetrators' ratings could indicate difficulties in cognitive processes, such as making inferences about others' emotional states, given that the subjects of the videos were people experiencing violence, and a particularly negative and intense perspective taking was expected. Together, these results appear to suggest difficulties with the perception of others' emotional states in the case of IPV perpetrators, as well as an impoverished mood state response to people undergoing negative emotions (Shamay-Tsoory, 2011), indicating potential empathic impairments in IPV perpetrators.

Regarding the third objective of this study, we proposed that the sOXT response would be related to the socio-affective variables (Procyshyn et al., 2020). Contrary to our expectations, the AUCi of the sOXT levels was unrelated to the mood state response, the perception of others' emotional state, or alexithymia. However, the AUCg of sOXT levels did correlate with a greater mood state response, with a more intense perception of the character's emotional state and lower alexithymia traits. These findings are of particular relevance because they suggest a relationship between higher sOXT levels and a greater understanding of one's own emotions, greater insight into the emotional state of others, and a more accurate emotional response to that emotional state, not only in IPV perpetrators. Furthermore, our results seem to indicate that these psychological variables could be more related to the total levels of sOXT rather than to changes in sOXT, highlighting the possibility of an OXT threshold that may favor socio-affective functions such as empathy. However, the literature on sOXT and its response to socio-affective functions is scarce (Hurlemann and Grinevich, 2018).

We also aimed to explore the predictive capabilities of these psychological variables in sOXT after the empathic induction task. Consistently, the mood state response and alexithymia predicted the AUCg of sOXT levels for the whole sample. As noted, alexithymia traits imply poorer emotional processing and response, and these two functions, in turn, have been shown to be necessary for empathy (Lyvers et al., 2018). Thus, it seems logical that an adequate emotional response and comprehension potentially explains lower sOXT levels after an empathic induction task, given its relevance in the salience of socio-affective information, and it suggests that the differences found in this study could be better understood based on the higher alexithymia scores reported in IPV perpetrators (Romero-Martínez et al., 2019a, 2019b, 2019c, 2019d, 2019e). Prior research provided evidence of a positive relationship between the mood state response and the changes experienced in peripheral pOXT (Barraza and Zak, 2009). Moreover, an inverse relationship between alexithymia and pOXT levels has been observed (Schmelkin et al., 2017). Therefore, our findings seem to be consistent with this literature, and they suggest that changes in the mood state and alexithymia may predict the levels of sOXT after an empathic induction task.

Finally, we investigated the difference in the performance of prosocial behavior between the IPV group and the control group, as well as the difference in sOXT levels after the empathic induction task between those who perform prosocial behavior and those who do not. We expected to find a greater sOXT response in the most prosocial subjects, regardless of whether they were IPV perpetrators or not (Marsh et al., 2015). As expected, IPV and controls showed similar prosocial behavior when making a donation. However, the participants who performed a prosocial behavior exhibited a greater AUCg of sOXT levels after the empathic laboratory task than those who did not, and no interaction effect between these two factors was found. Traditionally, violent behavior and prosocial behavior have been conceptualized as mutually exclusive (Marsh, 2019). However, this hypothesis is far from conclusive (Llorca-Mestre et al., 2017), and, currently, prosocial behavior has been related more to an effective functioning of empathy, whereas difficulties in empathy could be linked to violent behavior (Moya-Albiol, 2018; Romero-Martínez et al., 2019a, 2019b, 2019c, 2019d, 2019e). Hence, our results link the occurrence of prosocial behaviors to higher sOXT levels. This outcome may be relevant because sOXT levels have been related to understanding one's own emotions and to an appropriate emotional response to others' emotions, highlighting the importance of these variables in the occurrence of prosocial behavior.

4.2. Limitations and future research

To the best of our knowledge, this is the first study to focus on the sOXT response to a naturally induced empathic task in IPV perpetrators. Nonetheless, it has some limitations. First, a limitation of our study is the relatively small sample size. This limitation may be due to the difficulty of having access to the sample. Typically, men convicted of gender-based violence show strong initial resistance to the intervention, and this translates into a refusal to participate in the experimental phase (Santirso et al., 2020). A second limitation of our study may be the methodology used to elicit hormonal changes. Although recent studies have employed this empathic induction task to examine sOXT responses (Barraza and Zak, 2009; Procyshyn et al., 2020), some authors have indicated that empathic induction using social psychological methods could be characterized by higher ecological validity (Cabral et al., 2018). However, others have defended the efficacy of empathic induction tasks using emotional videos (Gilman et al., 2017). Moreover, it should be kept in mind that some authors have proposed that emotion recognition deficits in IPV perpetrators are limited to intimate partners (Marshall and Holtzworth-Munroe, 2010), whereas other studies revealed that IPV perpetrators presented a generalized emotion decoding ability impairment (Romero-Martínez et al., 2016b, 2019c). Therefore, these results are congruent or not with models such as the tend-and-befriend theoretical model or polyvagal theory. Another limitation could be the absence of a baseline measure of empathic abilities to assess their role when participants cope with this laboratory procedure (e.g., sOXT changes and/or levels). Finally, another limitation could be the fact that other relevant hormones for social cognition, such as testosterone and cortisol, were not taken into account (Procyshyn et al., 2020).

Further research is needed to elucidate the mechanisms that connect sOXT with socio-affective functions, encompassing not only the response to negative affect, but also to positive affect. In addition, it would be necessary to add measurements of sOXT after the prosocial laboratory task to provide more information about the possible differences between sOXT levels in individuals who exhibited prosocial behaviors and those who did not. Furthermore, it would be pertinent to explore the interaction of OXT with other hormones that are important for social cognition, such as testosterone and cortisol, because hormonal action is highly complex. Finally, extending the results of this study to other violent populations would increase the knowledge about the specific therapeutic needs of each of these populations. Therefore, given that difficulties in the socio-affective domain have been shown to be a convergent risk factor in IPV perpetrators, integrating the reinforcement of individual and contextual tools that enhance the correct functioning of empathy could increase the efficiency of intervention programs for men convicted of gender violence.

4.3. Conclusion

These results show, from the Biopsychosocial Model perspective, that IPV perpetrators may exhibit difficulties when responding to an empathic induction task. In addition, it appears that IPV perpetrators do not have an inability to perform prosocial behaviors, but risk factors such as an inadequate emotional response and poor emotional comprehension may hinder the empathic function (Moya-Albiol and Romero-Martínez, 2020). In sum, these results propose the existence of a bidirectional relationship between OXT and socio-affective functions, where OXT can change social behavior and, in turn, OXT levels can be changed in response to social stimuli. Thus, intervention programs, along the lines of the Good Lives model (Santirso et al., 2020), should focus not only on minimizing risk factors, but also on supporting protective factors (e.g., enhancing empathy), de-stigmatizing the violent population as incapable of being prosocial. In this regard, the analysis of sOXT seems pertinent for a holistic understanding of the empathic response; therefore, future research in this line seems relevant.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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