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ORIGINAL ARTICLE

Differential Effect of Emotional Stimuli on Performance on Verbal and Facial Priming Tasks and Their Relation to PTSD Symptoms in Girls with Intrafamiliar Sexual Abuse

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Abstract

Background Child sexual abuse (CSA) can generate PTSD and cognitive deficiencies. Studies using priming tasks have reported that adults with PTSD tend to remember threatening events better than pleasant or neutral ones.

Objective To determine whether girls with CSA present enhanced priming for negative emotional stimuli, and to identify the relationship between PTSD symptomatology and performance on priming tasks with different emotional content.

Method 48 girls (9–16 years old) were evaluated in three groups, each with 14 participants: (a) institutionalized with intrafamily child sexual abuse (CSA); (b) institutionalized without CSA (INS); and (c) non-institutionalized without CSA (NINS). All subjects performed verbal and facial priming tasks with emotional and neutral content.

Results The CSA group presented enhanced priming for both happy and scared faces compared to the NINS and INS groups. Performance on these faces correlated positively with the intensity of PTSD symptoms. Conversely, on the verbal priming task, that group presented lower performance regardless of the emotional valence of the words. In that case, performance correlated inversely with PTSD symptomatology.

Conclusions Results suggest that verbal and facial stimuli with emotional valence may have differential effects on girls with a history of CSA. The enhanced priming effect for emotional faces, together with the deficiencies in priming for words could, therefore, be associated with symptoms of re-experiencing in girls with CSA.

Keywords Child sexual abuse · Girls · Priming · Emotional stimuli · PTSD

Introduction

Child sexual abuse (CSA) is defined as involving children or adolescents in sexual activities that they cannot comprehend, or for which they are developmentally unprepared and unable to give informed consent (Kellogg, American Academy of Pediatrics Committee on Child, & Neglect, 2005). Preadolescent girls are at greater risk of being abused by males who are usually known to them, since family members account for 38.3% of cases, with acquaintances being responsible for another 46.3% (Anderson et al., 1993). CSA is related to long-term psychopathologies like posttraumatic stress disorder (PTSD), depression, and anxiety (Bagley, 1992). The fact that girls with CSA show a heightened vulnerability to PTSD compared to boys (Stoltenborgh et al., 2015; Tolin & Foa, 2002; Walker et al., 2004) may be due to a combination of genetic predisposition, hormonal influences, fluctuations in individual gender roles (Christiansen & Berke, 2020), stressor appraisal, and coping strategies (Tamres et al., 2002).

CSA generates chronic stress and, with this, a deregulation of the activity of the stress systems, especially the hypothalamic-pituitary-adrenal (HPA) axis (De Bellis et al.,

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1999; Sanz-Martin et al., 2019). It may also disturb development of such brain regions as the hippocampus, amygdala, prefrontal cortex, and temporal and occipital lobes (Andersen et al., 2008; Carrion et al., 2007; Dannlowski et al., 2012; De Brito et al., 2013; Heim et al., 2013; Tomoda et al., 2009a, 2011; Weniger et al., 2008).

These hormonal changes and their neurobiological effects can also contribute to the development of psychopathologies, such as PTSD, anxiety, and depression (Chen et al., 2010; Molnar et al., 2001; Paolucci et al., 2001; Roozendaal et al., 2009; Szeszko et al., 2018; Teicher et al., 2003), and to cognitive impairments in the working (Sanz-Martin et al., 2019) and explicit memories (Bremner et al., 1995). In relation to the latter, women with a history of CSA and PTSD have shown deficits in verbal declarative memory measured by the Wechsler Memory Scale-Revised (Bremner et al., 2004), associated with the severity of abuse (Bremner et al., 1995) and deficits in autobiographical memories (Henderson et al., 2002). Children with CSA and PTSD, in contrast, do not present obvious alterations in explicit memory (Beers & De Bellis, 2002).

In related aspects, it is well-known that the emotional content of information modulates memory consolidation to make memories more perdurable and accurate compared to neutral content (Reisberg, 2006). This effect depends on interactions among the amygdala, structures of the medial temporal lobe (Dolcos et al., 2004; McGaugh, 2000), and the prefrontal cortex (Shin et al., 2005).

The modulator effect of emotional information on memory is related to its valence and capacity to increase the subject's arousal (Reisberg, 2006). Therefore, the effect of emotional stimuli on memory may be greater in subjects who suffer induced psychosocial stress (Luethi et al., 2008), anxiety (McNally, 1997), and PTSD. (McNally et al. (1998), for example, studied women with histories of CSA, some of whom had PTSD, while others did not. In that study, participants were shown a series of trauma-related, positive, and neutral words, and were instructed to either remember or forget each one. Later, free recall, cued recall, and recognition tests were conducted for all the words, regardless of the initial instructions. The authors found that healthy subjects recalled more 'remember' words than 'forget' words, irrespective of valence, while the women with PTSD had difficulty in recalling the positive and neutral words they were supposed to remember but had no problem recalling the trauma-related words, including the ones they had been instructed to forget.

The influence of emotional stimuli is present in the implicit memory as well; that is, the process through which people's behavior, cognition, and emotions can be influenced by a past experience in the absence of any awareness of remembering it (Michael et al., 2005). Priming is one type of implicit memory in which there is an unintentional retrieval of previously-acquired information that does not require any conscious or explicit recollection of specific previous experiences, but can improve identification of such information when it is presented later (Schacter et al., 1991).

Adults with traumatic experiences and PTSD have shown enhanced priming for trauma-related words (Lyttle et al., 2010; Michael et al., 2005) and faces with negative emotional valence (Mazza et al., 2012), but the question of whether this phenomenon occurs in children and adolescents with PTSD has not been analyzed, except for one report on adolescents with anxiety. In that study, Sanz-Martin et al., (2018) reported that adolescent victims of bullying with anxiety showed better performance on verbal priming tasks with negative valence stimuli than on those with positive and neutral valence, but that this effect was not observed on the facial priming task applied. In that case, the adolescents with bullying but without anxiety, and the non-victims, had better performance with happy faces. Those authors suggested that the negative words were more aversive for the bullied teens than the angry faces, since verbal teasing and intimidation were the most common forms of violence at school and have become more severe due to the massive use of social networks. However, the verbal frightening stimuli generated facilitation in implicit memory only in the bullied boys with anxiety who had high basal arousal.

Emotional stimuli could have different effects on priming in adolescents compared to adults since the former have an imbalance between the top-down control system involved in regulating behavior and emotions and the bottom-up system involved in rewards and emotional activation (Casey et al., 2008; Romer, 2010). Specifically, adolescents show hyper-reactivity to emotional stimuli (Hare et al., 2005, 2008) because the amygdala and ventral striatum are hyperactivated as a result of increased levels of sex hormones, while the prefrontal cortex has lower activation since it is still in an immature state (Casey et al., 2005; Somerville et al., 2011).

As mentioned above, enhanced memory consolidation could trigger a maladaptive mechanism in which negative stimuli are processed more efficiently during times of stress. In this regard, Luethi et al., (2008) suggest that the enhancing effects of stress on the formation of implicit negative memories and attitudes provide a model of pathological emotional reactions, such as those found in PTSD.

PTSD is characterized by the re-experiencing of aspects of the abuse triggered by a remarkably wide range of external or internal stimuli that have no semantic connection to the trauma but are spatio-temporally linked to the event (Ehlers & Clark, 2000; Ehlers et al., 2004). Common examples are physical cues similar to those that were present shortly before, or during, the traumatic event (e.g., the

shape of a certain individual, spatial cues, smells, a pattern of light, certain phrases said in a certain tone of voice), similar emotional states (e.g., feeling helpless or trapped), or similar internal cues (e.g., a touch on a certain part of the body, proprioceptive feedback from one's own movements or posture) (Ehlers & Clark, 2000). Moreover, when re-experiencing the intrusive sensations and emotions from the trauma, people with PTSD may not even be aware that they are responding to a memory (i.e., lack of autonoetic awareness) and may respond as if they were experiencing such an intrusive memory at that moment (Ehlers & Clark, 2000).

Cognitive researchers have suggested that non-intentional or implicit memory processes are related to re-experiencing symptoms in individuals with PTSD (Michael et al., 2005) in the sense that stress could enhance the formation of implicit, unpleasant memories (Luethi et al., 2008). This phenomenon could be more intense in subjects during puberty and adolescence due to their hyper-reactivity to emotional events (Hare et al., 2005, 2008). For this reason, the study of implicit memory in children and adolescents with CSA could improve our understanding of the development of PTSD in pediatric populations.

In view of the possible participation of perceptual implicit memory in the development of PTSD in adults, and the scarcity of studies on this issue in children, the researchers decided to analyze whether children and adolescents with a serious history of CSA present enhanced priming for negative emotional stimuli. We also sought to identify the relationship between PTSD symptomatology and performance on verbal and facial priming tasks with different emotional content. Furthermore, given that girls are at a greater risk of being sexually abused and developing severe PTSD than boys (Christiansen & Hansen, 2015), only females were studied. The researchers hypothesized, first, that participants with a history of CSA will show an enhanced priming effect of emotional stimuli with negative valence on both verbal and facial tasks; and second, that the priming effect for emotional verbal and facial stimuli with negative valence will correlate with PTSD symptoms.

Method

Subjects

The study group consisted of 42, 9-16-year-old girls divided into three subgroups, each with 14 participants, as follows: (i) institutionalized girls with intrafamily child sexual abuse (CSA); (ii) institutionalized girls without CSA (INS); and (iii) non-institutionalized girls without CSA (NINS). Subjects in INS and NINS were matched with those in CSA with respect to age and school grade due to the wide age range of the participants and their different stages of development. Participants were selected by convenience sampling.

Subjects in the CSA and INS groups came from foster homes where they had lived for at least 6 months. None were institutionalized before the age of 3 years. The girls in the CSA group were institutionalized to protect them from the recurrent intra-family sexual abuse of which they were victims, and because they had no family members who could care for them. These girls had suffered rape or caresses of their sexual organs or been forced to watch sexual acts and prostitution. Their abusers were stepfathers, stepbrothers, fathers, brothers, uncles, or clients of mothers who practiced prostitution. In three cases, the girls were abused also by a teacher in the school they attended. Sexual abuse began between the ages of 3 and 11 years. The girls had also suffered poverty, negligence, physical and psychological abuse and, in some cases, had witnessed domestic violence.

Participants in the INS group had been placed in foster homes due to poverty, negligence, or abandonment, or because their parents could not care for them. Both groups of institutionalized participants were recruited from three foster homes registered under the Mexican Official Norms for Assistance Services for Children (Nom-167-SSA1-1997), which ensured that their needs for housing, education, clothing, food, and mental and physical health services were attended to. For the girls in CSA and INS, two clinical psychologists verified the background of early adversity by reviewing legal, psychological, and medical files at the foster homes, interviewing caregivers, and applying the Child Abuse Screening Tool-Children's Version (ICAST-C) (Zolotor et al., 2009).

Participants in the NINS group were recruited from public schools in the metropolitan area of Guadalajara, Mexico, with a medium socioeconomic level. They were living with their families and had no history of child maltreatment according to the ICAST-C (Zolotor et al., 2009). This questionnaire was also applied by two clinical psychologists.

Only potential participants who met the following inclusion criteria were included in the study: IQ above 80, no use of illegal drugs or alcohol, a school delay of no more than two years, and absence of learning disabilities and attention deficit disorder.

All participants had normal IQs according to the brief form of the WISC-IV-R, (Wechsler, 2007) (Table 1), and attended school regularly. No girl in any group had failed more than one school grade according to reports by teachers, parents, or caregivers. They were all healthy and had no prior history of neurological disorders, learning disabilities, attention deficit disorder, or chronic illness, according to their records (in the case of the institutionalized participants), and clinical histories extracted using the Child Neuropsychological Assessment ENI (Matute et al., 2013),

which was answered by parents, caregivers, or foster-home psychologists.

All procedures involved in this research were approved by the Ethics Committee of the Institute of Neuroscience (registration number ET012014-155) in accordance with the ethical standards laid down in the 1964 Helsinki Declaration. All participants and their parents or guardians gave their informed consent prior to inclusion in the study.

Table 1 Characteristics of the CSA, INS and NINS groups (G) and statistical comparisons among them

		Mean	Standard deviation	$F_{2,41}$	p	η^2
Age	CSA	11.43	1.604	0.060	0.942	0.003
	INS	11.50	1.787			
	NINS	11.64	1.598			
PTSD global score	CSA	41.00	16.747	47.844	**0.000**	0.710
	INS	6.50	8.510			
	NINS	3.07	5.784			
PTSD Re-experimentation	CSA	3.500	1.5064	39.467	**0.000**	0.669
	INS	0.571	0.8516			
symptoms	NINS	0.286	0.6112			
PTSD	CSA	3.786	1.8472	33.126	**0.000**	0.629
Avoidance /	INS	0.714	0.9139			
dissociation	NINS	0.286	0.6112			
PTSD	CSA	3.500	1.2860	43.480	**0.000**	0.690
Arousal /	INS	0.643	0.9288			
symptoms	NINS	0.357	0.6333			
Anxiety	CSA	61.857	12.5995	2.198	0.125	0.101
	INS	58.643	12.3948			
	NINS	52.786	9.5851			
Depression	CSA	54.571	15.6043	2.826	0.071	0.127
	INS	46.214	7.6478			
	NINS	45.214	9.5045			
Estimated IQ	CSA	91.143	6.1875	13.006	**.000**	0.4
	INS	96.571	9.9747			
	NINS	107.929	9.9573			

*n = 42

Columns four, five, and six present the F_{fg} values, significance (p), and size effect (r) of the ANOVAs conducted to compare the group values for each variable. *significant differences. N = 42

Instruments

To select participants, short form of the WISC-IV (Wechsler, 2007) and the ICAST-C (Zolotor et al., 2009) were applied. The researches also interviewed the parents or caregivers and applied a questionnaire designed to obtain clinical histories (Matute et al., 2013). This approach allowed us to elucidate each girl's pathological and non-pathological antecedents and the characteristics of their current condition.

The ICAST-C is a set of screener questions about each type of victimization, elaborated to permit mapping the categories of assault or child maltreatment. The home module includes 38 items about physical abuse, physical discipline, sexual abuse, neglect, and psychological abuse, while the institutional module has 44 items related to sexual assault, physical assault, and psychological victimization. Children are given the response options of "many times," "sometimes," "never", and "not in the past year, but this has happened." When children respond affirmatively, they are asked to identify the perpetrator as "adult," "another child or adolescent", or "both." The internal consistency of the questionnaire was moderate-to-high (alpha between 0.685 and 0.855) (Zolotor et al., 2009).

In addition, three Spanish versions of clinical scales were applied to determine the presence and intensity of symptoms of PTSD, depression, and anxiety. The first one was the Child PTSD Symptom Scale (CPSS) (Bustos et al., 2009), which was validated in 75 children and adolescents with sexual abuse with Cronbach's alpha values between 0.78 and 0.92. It is composed of 17 Likert-type items and has 3 subscales: re-experiencing (5 items), avoidance (7 items), and increased activation (5 items). The second was the Children's Depression Inventory (CDI) (Kovacs, 2004), which consists of 27 Likert-type items with Cronbach's alpha values between 0.75 and 0.94. The third was the Spence Children's Anxiety Scale (SCAS) (Hernández-Guzmán et al., 2009), which was validated with 554 children and had Cronbach's alpha values between 0.72 and 0.88. The SCAS has 38 Likert-type items grouped in 6 subscales (obsessive compulsive disorder, social phobia, panic agoraphobia, separation anxiety, fear of physical injury, and generalized anxiety).

Priming Tasks

Word Completion Task

The researchers asked participants to read a series of 24 full-words in Spanish (8 with positive emotional valence [e.g., travel, sleep], 8 with negative emotional valence [e.g., knife, hurt], and 8 neutral ones [e.g., telephone, lime], presented one-by-one on cards for 10 s. We then instructed them to rate each word on a 1–5 scale according to their familiarity with it (1 = least familiar, 5 = most familiar). After 10 min, 60 cards were presented with incomplete words, 24 of which were the same words as above, while 36 were new. Each card was shown for 5 s, and the participant had to say the word that might be represented. We counted the total number of correct words (previous and new) for each type of emotional content (positive, negative, neutral). The priming effect was calculated by subtracting the percentage of the new words completed correctly from the percentage of previously-seen words completed correctly. Positive values indicated that previously-seen words were remembered

better than new ones. Thus, positive values that were significantly greater than zero indicated the presence of a priming effect.

The emotional words used on the verbal priming task had been used in an earlier study (Sanz-Martin et al., 2018) where they were chosen through the following process. First, 84 children and adolescents aged 10–17 were asked to mention things that made them feel "good" (pleasant) or "bad" (unpleasant). They provided 208 words. Next, the 74 most frequent words (43 unpleasant, 31 pleasant) were selected, and 24 associated with child abuse and violence from the ICAST-C questionnaire (Zolotor et al., 2009) (e.g., loneliness, beating, slapping, etc.) were added. The words obtained from the survey and those taken from ICAST were written on white cards and shown to 10-17-year-old institutionalized children and adolescents (11 boys, 10 girls), who were asked to separate the words that made them feel good from those that made them feel bad, and then arrange each set of words in descending order, beginning with the one that caused them the most intense emotion and working down to those that generated less emotion. This ordering process allowed us to assign a number to each word. Finally, we calculated the median of each word, selected the 20 most pleasant and 20 most unpleasant ones, and included an additional 20 words with neutral emotional content extracted from a battery used to evaluate attention and memory, previously standardized for the Mexican population (e.g., pear, eyebrow, goat) (Ostrosky-Solís et al., 2003).

Faces

On the second task, facial priming, a set of 30 photographs with facial expressions (10 scared, 10 happy, 10 neutral) were presented randomly on a computer screen for 1000 ms with an inter-stimulus interval of 750 ms. We instructed participants to indicate if it was the face of a man by pressing the key '1', or key '7' if it was a woman. Ten minutes later, the same images were presented randomly (one-by-one) but mixed with another 30 photos. At that time, we asked participants to indicate, by pressing key '1', if the image had been shown previously (old image), or key '7' if they thought it appeared for the first time (new image). The images with facial expressions (scared, happy, neutral) selected for this task had been piloted and used in an earlier study (Sanz-Martin & Calderón-Zepeda, 2016).

In this stage, the total number of correct responses and the mean reaction times (RT) for both the previously-seen and new faces, and for each emotion (fear, happiness, neutral) were measured. The priming effect was calculated in two ways: (i) by subtracting the number of correct responses for new faces from the number of correct responses for previously-seen faces; and (ii) by subtracting the mean RT for previously-seen faces from the mean RT for new faces. In the first case, positive values indicated that previously-seen words were better remembered than new ones. In the second, we assumed that if a priming effect were present, RT would be lower for previously-seen faces than new ones.

Procedure

Participants were assessed in three one-hour sessions. In the first two, we evaluated IQ, depression, anxiety, and PTSD symptoms, and the characteristics and frequency of the violence reported by the girls. Next, we asked the girls who met the inclusion criteria to attend an assessment session held at the receiving institution (foster home or public school). All evaluations were performed in rooms without noise and with good lighting and ventilation.

Data Analysis

One-factor ANOVAs were conducted to determine significant differences in the demographic data, psychopathological symptoms, and estimated IQs among the three study groups. Next, given that IQ was significantly higher in the NINS group than the CSA and INS groups (Table 1), Pearson's correlations were calculated to determine if there was a positive relation between IQ and performance on the verbal and facial priming tasks. Since there was no significant correlation between those variables, split-plot ANOVAs (3 groups × 3 emotional valences) were applied to compare the verbal and facial priming task scores. In addition, split-plot ANCOVAs (3 groups × 3 emotional valences) with IQ as the covariant were performed. For each analysis, the sphericity condition was tested by Mauchly's test. When this was not met, the degrees of freedom were corrected using the Greenhouse-Geisser method. Post hoc tests corrected by Bonferroni's method to determine the direction of the differences were used. The effect size of each result was also calculated.

Pearson's correlations among the scores for PTSD, anxiety, and depression, and the results of the verbal and facial priming memory tasks for all participants and each group were performed. Statistical significance was considered at an alpha < 0.05.

Results

As Table 1 shows, there were no significant differences among the groups in age or anxiety and depression symptoms. However, the CSA group showed a higher intensity of PTSD symptoms (re-experiencing, avoidance/dissociation, arousal) than the other two groups. Finally, CSA and

INS had lower IQs than NINS. Considering the differences among groups in IQ, Pearson's correlations among this variable and the behavioral data from the verbal and facial priming tasks were performed, but no significant correlation

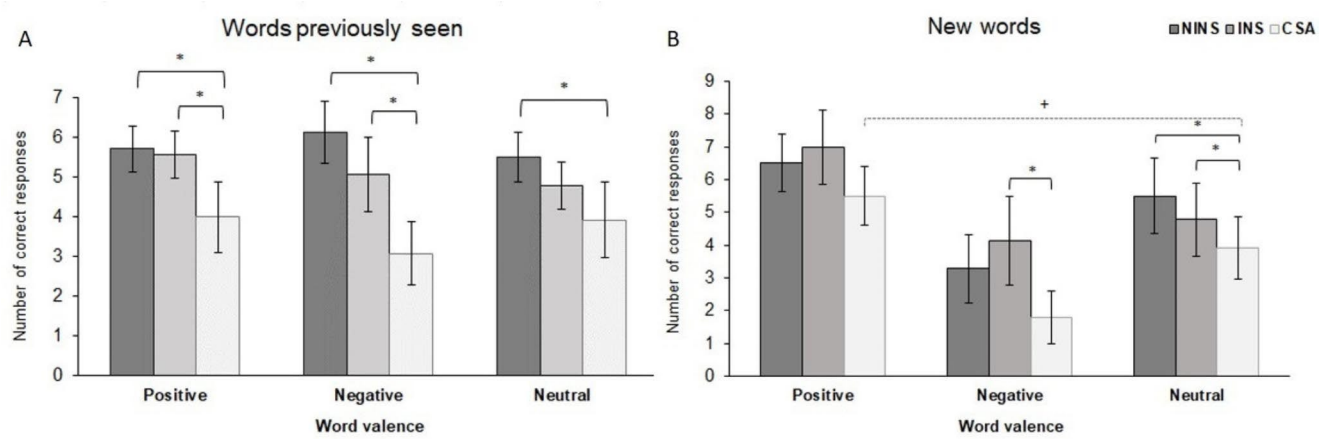

Fig. 1 Number of correct responses (Mean ± 2 S.E.) for previously-seen (A) and new words (B) on the word completion task. *Significant difference ($p < .05$) among positive, negative, and neutral words. +Significant differences among non-institutionalized girls without child sexual abuse (NINS), institutionalized girls without child sexual abuse (INS), and institutionalized girls with child sexual abuse (CSA). In graph B, all three groups had fewer correct responses to words with negative valence. N = 42

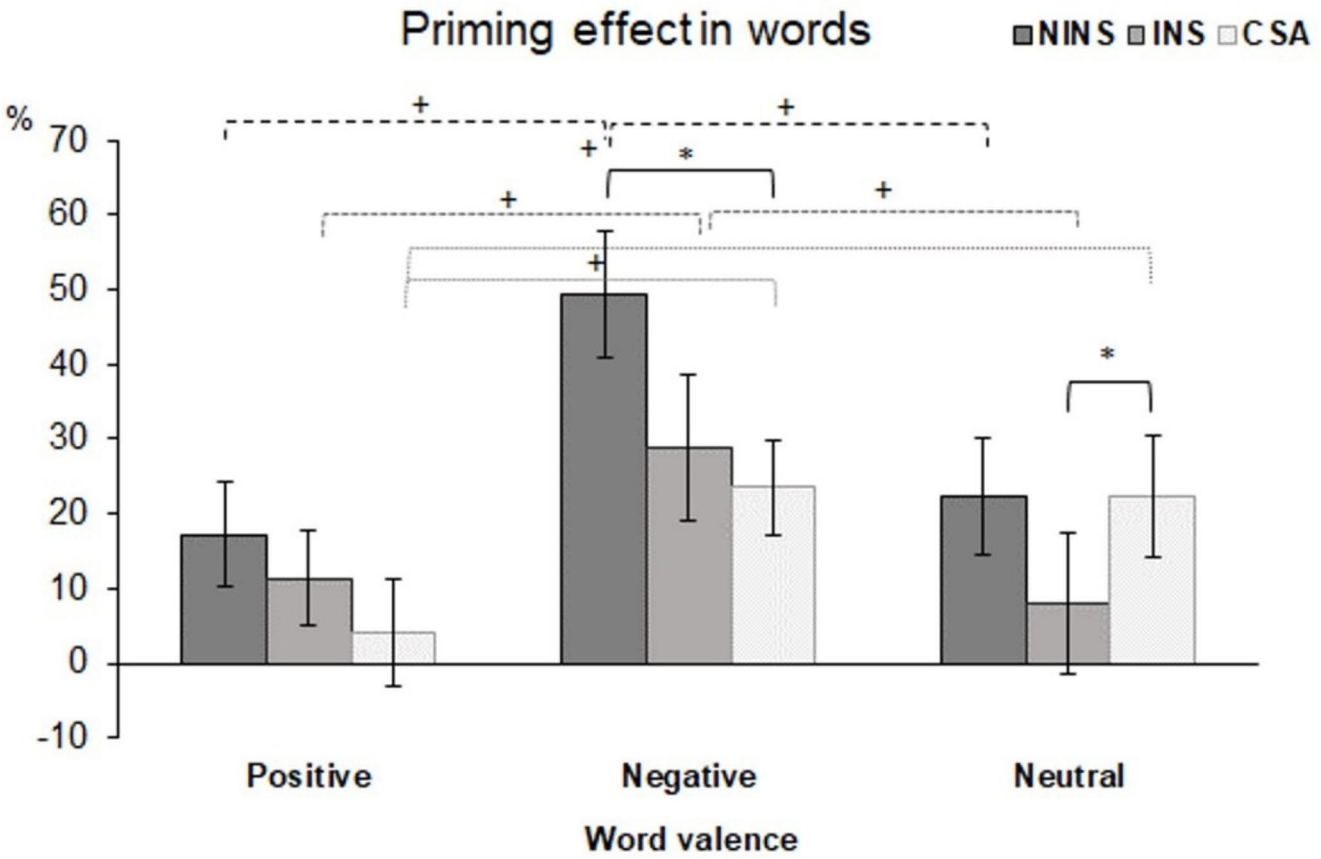

Fig. 2 Priming effect (mean difference ± 2 S.E.) on the word completion task. The priming effect was present when the difference in the percentage of correct responses to the words seen previously and the new ones was positive. *Significant difference ($p < .05$) among positive, negative, and neutral words. +Significant differences among non-institutionalized girls without child sexual abuse (NINS), institutionalized girls without child sexual abuse (INS), and institutionalized girls with child sexual abuse (CSA). N = 42

was determined between IQ and any of the behavioral parameters.

Verbal Priming

The ANOVA for the correct responses of previously-seen words showed a main effect of group ($F(2,39) = 13.53$, $p < .000$, $\eta^2 = 0.410$), but no effect of word valence ($F(2,78) = 1.39$, $p = .254$, $\eta^2 = 0.034$). There was a marginal interaction between group and emotion ($F(4,78) = 2.4$, $p = .057$, $\eta^2 = 0.110$). Similar results were found with the ANCOVA, where there was a main effect of group ($F(2,38) = 6.95$, $p = .003$, $\eta^2 = 0.268$), but no effect of word valence ($F(2,76) = 2.19$, $p = .119$, $\eta^2 = 0.054$). There was no interaction between the factors group and emotion ($F(4,76) = 0.798$, $p = .530$, $\eta^2 = 0.05$), or between emotion and IQ ($F(4,76) = 1.99$, $p = .143$, $\eta^2 = 0.04$). In the post hoc analyses, CSA had fewer correct responses on the words with positive and negative valence than INS and NINS, and fewer correct responses than NINS on the neutral words (Fig. 1 A).

Regarding the new words, the ANOVA showed a main effect of group ($F(2,39) = 5.068$, $p < .011$, $\eta^2 = 0.206$) and word valence ($F(2,78) = 55.16$, $p < .000$, $\eta^2 = 0.586$), but no interaction between the factors group and emotion ($F(4,78) = 1.55$, $p = .197$, $\eta^2 = 0.073$). Similar findings were determined with the ANCOVA, which evidenced significant main effects of group ($F(2,38) = 6.733$, $p = .003$, $\eta^2 = 0.262$) and word valence ($F(2,76) = 3.3$, $p = .042$, $\eta^2 = 0.08$), but no interaction between these variables ($F(4,76) = 1.693$, $p = .160$, $\eta^2 = 0.082$), or between emotion and IQ ($F(4,76) = 1.931$, $p = .152$ $\eta^2 = 0.048$). Post hoc analyses revealed that CSA had fewer correct responses on words with negative emotional valence than INS, and fewer hits on neutral words than both INS and NINS (Fig. 1B). In addition, CSA had fewer hits on neutral than positive words, and all participants, regardless of group, completed fewer words with negative emotional content (Fig. 1B).

With respect to the priming effect, the ANOVA demonstrated a main effect of group ($F(2,39) = 13.53$, $p < .000$, $\eta^2 = 0.410$), but no main effect of word valence ($F(2,78) = 1.39$, $p = .254$, $\eta^2 = 0.034$). There was, however, a marginal interaction between group and emotion ($F(4,78) = 2.403$, $p = .057$, $\eta^2 = 0.110$). The ANCOVAS showed a main effect of group ($F(2,38) = 4.22$, $p = .022$, $\eta^2 = 0.182$) and an interaction between group and emotion ($F(4,76) = 3.157$, $p = .019$, $\eta^2 = 0.142$), but no main effect of word valence ($F(2,76) = 0.635$, $p = .532$, $\eta^2 = 0.016$), or interaction between emotion and IQ ($F(4,76) = 0.820$, $p = .444$, $\eta^2 = 0.021$). Post hoc analyses showed that CSA had a lower priming effect than NINS on the negative words but a higher priming effect on neutral words than INS. As Fig. 2 shows, the INS and NINS groups had higher priming effects on negative than positive and neutral words, but CSA only presented this difference on positive words.

Facial Priming

Regarding the number of correct responses for previously seen and new faces, the ANOVAS revealed a significant main effect of emotion but no effect of group or interaction between groups and emotions (Table 2). Post hoc analyses indicated that the number of correct responses was higher for happy faces than scared and neutral ones, and higher for scared faces than neutral ones. The ANCOVA did not show a main effect of group or facial expression, or interaction between these factors or between facial expressions and IQ (Table 3).

Table 2 ANOVAS performed with the scores from the visual priming task

	Group			Emotions			Interaction group and emotion		
	$F_{2,39}$	**p**	η^2	**$F_{2,78}$**	**p**	η^2	**$F_{4,78}$**	**p**	η^2
	1.27			19			1.01		
				0.76			2.24		
New faces									
	1.06			11.4					
	2.13			1.67					
Cal-				14.6			1		
Cal-	2.37	0.110	0.107	0.545	0.583	0.014	3.87	**0.007**	0.165

* Freedom grade corrected using the Greenhouse-Geisser method

n = 42

Table 3 ANCOVAS performed with the scores from the visual priming task

	Group		Emotions		Interaction group and emotion		Interaction group and IQ	
	p	η^2	**p**	η^2	**p**	η^2	**p**	η^2
			0.2					
			2.1					
	2.1							
			2.7	***.08***				
Cal-	1.03		0.63	0.5*	3.51			

* Freedom grade corrected using the Greenhouse-Geisser method.

n = 42.

The RT for previously-seen and new faces showed no main effects of group or facial expression, and o interaction between these factors or between facial expressions and IQ (Tables 2 and 3).

The ANOVA for the priming effect calculated on the basis of the number of correct responses revealed a significant main effect of emotion but no effect of group and no interaction between groups and emotions. Post hoc analyses showed that only CSA manifested a priming effect for scared faces (Fig. 3a). Conversely, the ANCOVA only showed a borderline main effect of group (p = .08) (Table 2).

Finally, an additional ANOVA for the priming effect calculated with RT was performed. This showed an interaction between group and emotion, with the CSA group manifesting a priming effect for happy and scared faces (Fig. 3). There were no main effects of group or emotion. The same results were found with the ANCOVA (Table 3).

Correlations between Psychopathology and the Priming Effect

The Pearson's correlation analyses performed with all participants showed significant correlations between PTSD symptoms and performance on the verbal and facial priming tasks only for the emotional stimuli. Specifically, there was a moderate negative correlation between CPSS and priming effect scores for words with positive and negative valence. On the facial priming task, there were moderate positive correlations between CPSS scores and the priming values calculated with RT for the happy and scared faces (Fig. 4).

In addition, Pearson's correlation analyses for each group were conducted. In CSA, there was a high negative correlation between CPSS scores with a priming effect value calculated with correct responses for happy faces (r = – .695, p = .006). In contrast, INS presented a significant positive correlation between CPSS scores and a priming effect value calculated with correct responses for the scared faces (r = .552, p = .041).

Discussion

The purposes of this study were to determine whether girls with CSA present enhanced priming for negative emotional stimuli, and to identify the relation between PTSD symptomatology and performance on verbal and facial priming

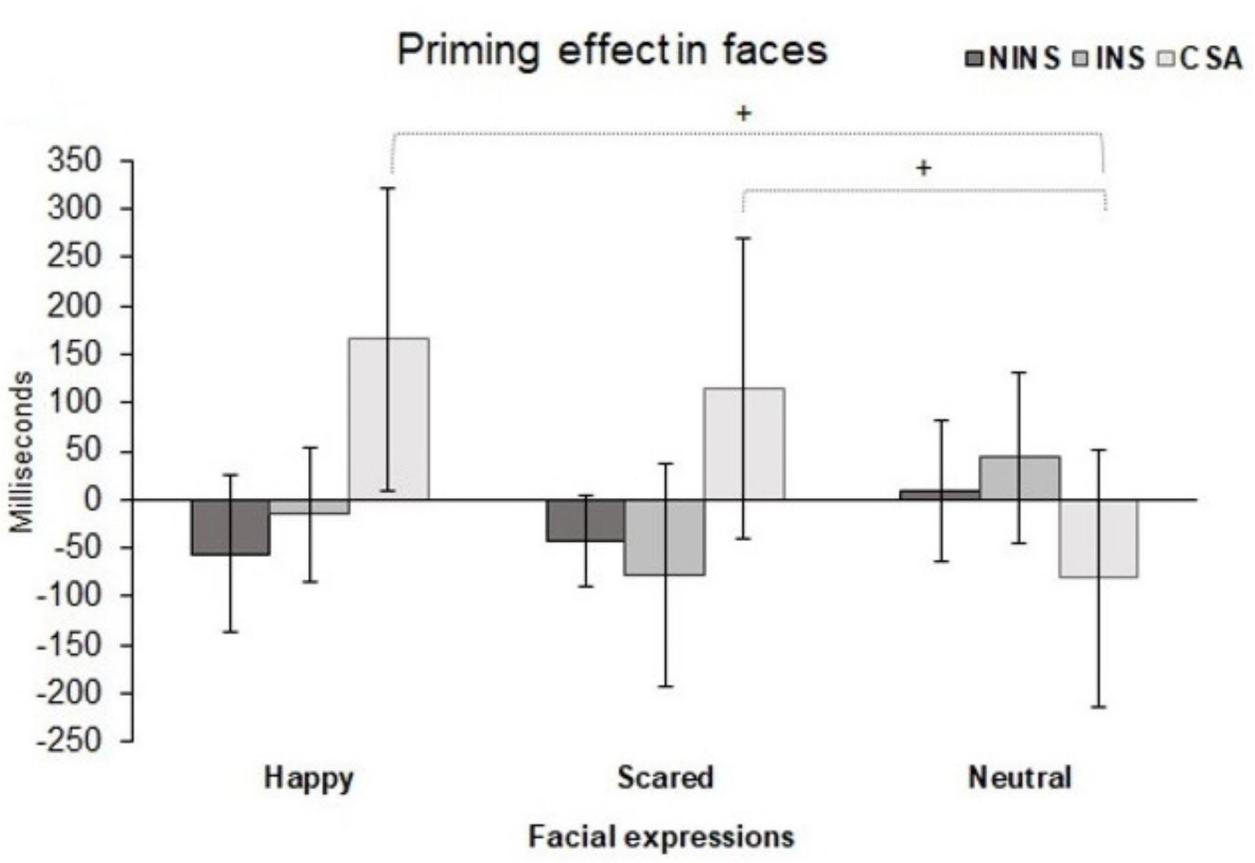

Fig. 3 Priming effect (mean difference ± 2 S.E.) on the visual task. A priming effect was present when the difference between the RT of the correct responses of new faces and the previously-seen ones was positive. +Significant differences among non-institutionalized girls without child sexual abuse (NINS), institutionalized girls without child sexual abuse (INS), and institutionalized girls with child sexual abuse (CSA). N = 42

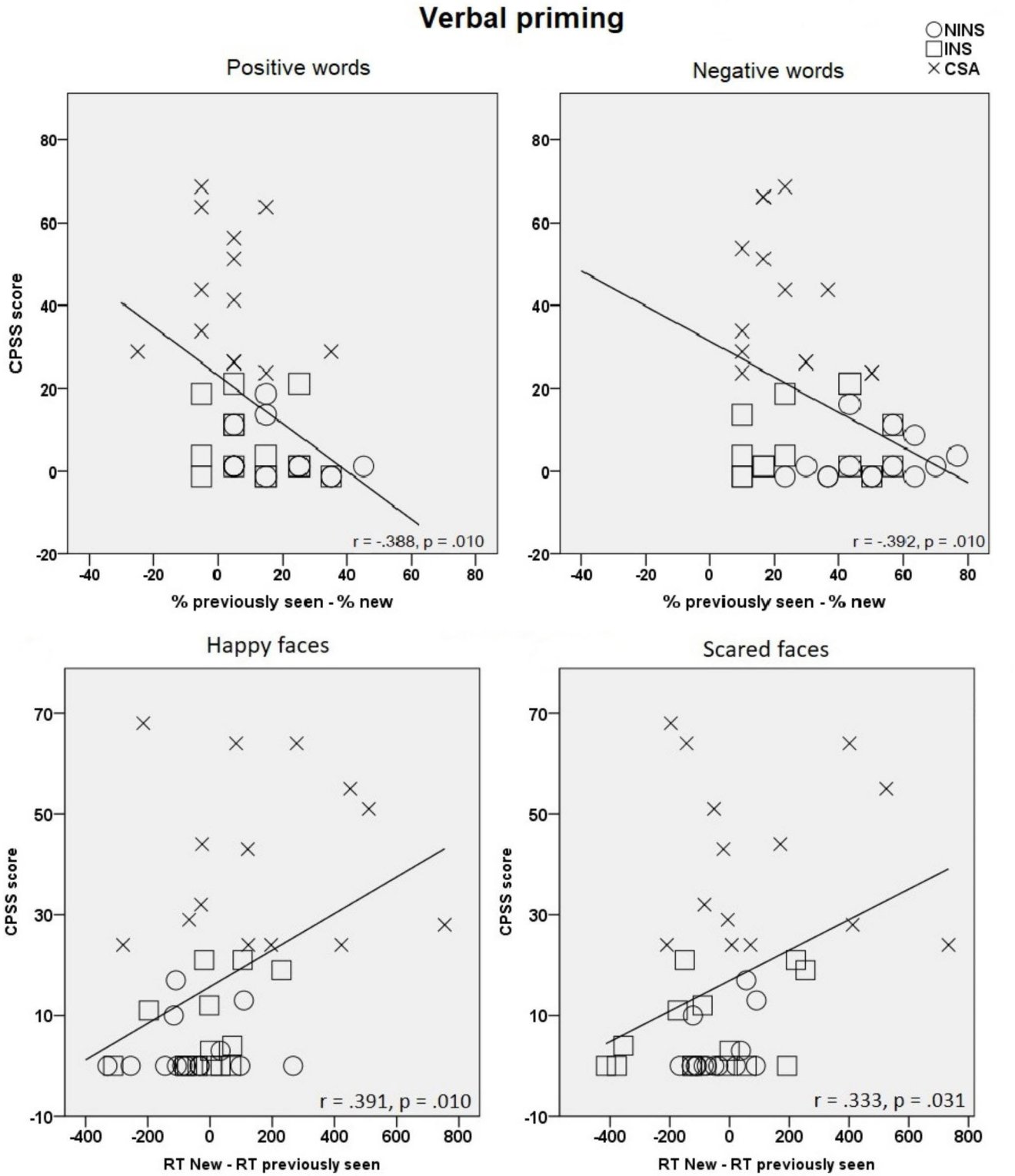

Fig. 4 Scatter plots showing the correlation between CPSS scores and the priming effect on the word competition and facial tasks. NINS, non-institutionalized girls without child sexual abuse; INS, institutionalized girls without child sexual abuse; CSA, institutionalized girls with child sexual abuse

tasks with different emotional content. Contrary to our expectations, results showed a distinct pattern in the girls' performance on the verbal and facial priming tasks. Thus, while the CSA group presented enhanced priming for both

happy and scared faces compared to NINS and INS, on the verbal priming task that group presented lower performance regardless of the emotional valence of the words. Besides, their performance on verbal and facial tasks was related to the intensity of PTSD symptoms.

The results show that words with negative valence had enhanced priming in all participants, and that this effect was present regardless of their backgrounds of early adversities and institutionalization. In this regard, it is known that emotional events tend to be remembered well and more accurately, and seem to be more long-lasting than neutral ones, so while they will eventually be forgotten, the rate of forgetting is slower than for neutral episodes (Reisberg, 2006).

On the verbal priming task, the girls with CSA showed worse performance than those in NINS and INS on all three types of stimuli, while execution in all groups correlated negatively with PTSD symptomatology. This result differs from those found in adults with PTSD who show enhanced priming for trauma-related words (Lyttle et al., 2010; Michael et al., 2005). The inconsistency between our results and those studies could be due to the fact that experimental words with negative valence provide only a weak approximation to real-life traumatic stimuli even though many were obtained from a child abuse questionnaire (ICAST-C) and had been piloted in institutionalized children.

It may be that the generally lower performance on verbal priming by girls with CSA reflects increased vulnerability to the effects of stress compared to adults due, among other variables, to maturational changes in the nervous system. In this regard, the imaging experiments that have performed variants of the word-stem completion task have found involvement of the occipitotemporal region, left angular gyrus, and left inferior frontal and right anterior frontal cortices (Henson, 2003). These brain areas have shown morphological alterations in children and adults with a history of CSA (De Bellis, Keshavan, et al., 2002; De Bellis, Keshavana, Bellis et al., 2002a, b; Tomoda et al., 2011>; Tomoda, Suzuki, Tomoda et al., 2009a, b).

In addition, the deficient verbal priming exhibited by girls with CSA can be related to the verbal memory deficiencies of PTSD. In this regard, we found that children with trauma-related PTSD evidenced lower scores on verbal memory tasks (Samuelson et al., 2010; Yasik et al., 2007).

With respect to the facial task, only the girls with CSA showed a priming effect for happy and scared faces. The presence of an enhanced priming effect for scared faces agrees with findings in studies of adults. Mazza et al., (2012), for example, found that adults with PTSD presented increased sensitivity to negative facial effects on a subliminal priming task with higher activation in the right insula and left amygdala than healthy controls who had greater activation of the left lingual gyrus.

It is probable that, unlike emotional words, the enhanced priming effect of emotional faces observed in the girls with CSA occurred because these stimuli approximate more closely real-life traumatic stimuli related to sexual abuse and that recognition of emotional faces (as opposed to verbal priming), may be a vital survival skill (da Silva Ferreira et al., 2014).

An unexpected finding on the facial task was that the girls with CSA showed a priming effect on both happy and scared faces. Currently, we propose that this result could be a consequence of the anomalous affective contexts in which girls with CSA develop because they have suffered intra-familiar sexual abuse. In this regard, there are descriptions that girls in incestuous families grow up in a dysfunctional ambiance in which the non-abusing parent is not available and the abusing parent is available only in an inappropriate and destructive manner (Madonna et al., 1991). Levang (1989), for example, found that in this kind of family there was very little communication between daughters and their mothers, and negative feelings between husband and wife. In cases of brother-sister incest, parents frequently respond negatively toward the girl and may even blame her, so the psychosocial distress levels that these girls experience is almost the same as that of victims of father incest (Cyr et al., 2002). The girls in our sample had been abused by a close male relative who, on many occasions, used seduction to approach his victim. In an abusive context of this kind, girls might well come to associate happy faces of adults, especially males, with sexual abuse. It is for this reason that both happy and scared faces could be salient stimuli involved in an abusive context that can activate the trauma. In this regard, several studies have shown that trauma and PTSD symptoms can be activated by context, regardless of its emotional valence (Grossman et al., 2017; Hoffman et al., 2017).

On that point, some studies have reported abnormalities in the processing of facial emotions in maltreated children that very depending on the type of abuse experienced; for example, while children who suffer institutional negligence have difficulties in discriminating emotions in general (Pollak et al., 2000), victims of physical abuse show better recognition of angry and scared faces (Masten et al., 2008; Pollak et al., 2000). Pollak (2002; 2001) have proposed that the greater sensitivity to recognizing angry faces in children who have suffered physical abuse is due to the constant need to control their actions (fight or flight) in order to avoid the pain associated with severe punishment. In the case of the girls with CSA in our study, the greater sensitivity to the happy and scared faces could represent an adaptive advantage that facilitates survival in a hostile environment.

Finally, it is important to discuss the differential effect of verbal and facial emotional stimuli on the priming task in the girls with CSA. As we mentioned, these girls showed

general impairment on the verbal priming task with an enhanced priming effect on the visual task for emotional faces. We consider that this difference could be related to the greater alteration of the left neocortex compared to the right one, as has been reported in previous studies with abused children and adolescents (Miskovic et al., 2010; Teicher et al., 2003). Moreover, while children with PTSD had significantly lower scores on discrete measures of verbal intelligence assessed by the WISC-III relative to traumatized PTSD negatives and non-traumatized controls, they do not present lower estimates of performance intelligence (Saigh et al., 2006).

The differential performance on the verbal and facial priming tasks by the girls with CSA may also be related to the symptoms that characterize PTSD, since it has been suggested that anxiety motivates avoidance of semantic elaboration and/or promotes perceptual encoding of threat information, such that it is stored in memory in forms that are not verbally accessible and, therefore, does not aid in the retrieval of threat representations (Mathews, 2006). This suggests that the development of PTSD is characterized by the presence of memory alterations because, while the intentional recall of the stressful event is often disorganized or incomplete, involuntary memory fragments are readily and unwittingly activated by perceptual signals (Halligan et al., 2002).

Finally, we recognize that our study has limitations, mainly the small sample size due to the difficulty to recruit participants who met the inclusion criteria. Although girls from three foster homes in the state of Jalisco, Mexico were screened, it was not possible to obtain a larger sample because many potential subjects had low IQs, were in a school grade below their age, or had a personal or maternal history of drug use. Second, participants with CSA had increased PTSD symptoms so, it was impossible to distinguish between the impact of PTSD and that of child sexual abuse. In fact, there were robust correlations between performance on the priming task and CPSS scores. The severity of the PTSD symptoms may be explained by our finding that the CSA participants were victims of intra-family sexual abuse and, therefore, had been removed from their homes.

Third, the participants in the NINS group had higher IQs than those in CSA and INS. Though lower IQ is a common finding in abused children, it is important that future studies control certain variables that may impact children's cognitive development, such as parents' educational level and socioeconomic level. In addition, it may be helpful to control for participants' reading level because this factor can influence word recognition. A fourth limitation could be the differences between the verbal and facial priming paradigms employed, since the first task was presented on paper and the second by computer. Also, the words presented on this task belonged to the day-to-day lexicon of the participants and, hence, may have been more easily retrieved later because they are more readily-integrated into existing schemes, and because this knowledge can be used intentionally as a retrieval strategy. In contrast, the stimuli from the facial task had never been seen before the evaluation, so their recovery may well have been more difficult. We consider, therefore, that it would be useful to measure response times on verbal tasks as well. Finally, the PTSD symptoms were measured using a DSM-IV scale that was validated in Latin America.

In terms of future research, it would be interesting to study the effects of verbal and facial stimuli with negative valence on priming in subliminal paradigms, and to compare any differences in performance when male and female faces are used.

In conclusion, this study shows that verbal and facial stimuli with emotional valence may have differential effects on children with a history of CSA. Participants' performance on both kinds of priming tasks correlated with their PTSD symptoms. The enhanced priming effect for emotional faces and the deficiencies in priming for words could be associated with PTSD and symptoms of emotional dysregulation in children with sexual abuse.

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Declaration

Conflict of Interest The authors report that they have no conflicts of interest.

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