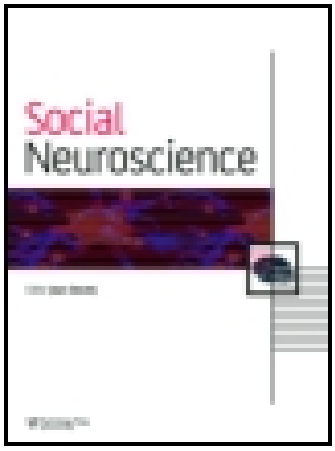

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Police culture influences the brain function underlying compassion: A gender study

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Police culture influences the brain function underlying compassion: A gender study

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Compassion is a prototypical moral emotion supporting cooperation and involves empathic decision-making and motor processes representing the interplay of biologically evolved and cultural mechanisms. We propose a social neuroscience approach to identify gender differences and to assess biological and cultural factors shaping compassion. We consider the police force as a cultural model to study this emotion, because it comprises a mixed-gender group using specific codes for collective safety that influence empathy and cooperativeness. From a sample of Mexican police officers working in a violent environment we integrated ethnographic data categorizing compassionate elements in the officers' activities, psychometric measures evaluating empathic attitudes, and fMRI scans identifying the brain activity related to compassionate experiences and decisions. The results suggest that the police culture influences genders equally with respect to empathic behavioral expressions. Nevertheless, women showed insular and prefrontal cortical activation, suggesting a more empathic experience of compassion. Officers manifested activity in the caudate nucleus, amygdala, and cerebellum, suggesting a more a highly accurate process to infer another's suffering and a reward system motivated by the notion of service and cooperation, both of which are cultural traits represented in the police force.

Keywords: Compassion; Police; Gender; fMRI; Ethnography.

Compassion can be considered a prototypical moral emotion involving feelings of affliction elicited by perceiving suffering in others that motivates one to alleviate the suffering and to maintain social bonds. Compassion also involves moral values influencing personal judgments and social cooperation (Haidt, 2003). Experimental situations designed to study the neural basis of compassion using neuroimaging techniques include Buddhist meditation (Lutz, Brefczynski-Lewis, Johnstone, Davidson, & Baune,

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2008; Weng et al., 2013), hearing narratives and imagining scenes of psychological and physical pain (Immordino-Yang, McColl, Damasio, & Damasio, 2009; Kédia, Berthoz, Wessa, Hilton, & Martinot, 2008), reading statements and watching pictures intended to elicit compassion (Kim et al., 2009; Mercadillo, Díaz, Pasaye, & Barrios, 2011; Moll, de Oliveira-Souza, & Eslinger, 2003), and making altruistic decisions (Moll et al., 2006). These reports indicate that compassion involves empathy, theory of mind, decision making, and motor processes that are regulated by the function of superior parietal, prefrontal, and temporal regions, as well as of the cerebellum, basal ganglia, and insula.

Since the adaptive function of compassion is related to collective safeguarding, it involves the interplay of both biologically evolved mechanisms and culturally shaped experiences (Mercadillo & Arias, 2010). Accordingly, the neurobiological basis of compassion can be studied from social neuroscience experiments showing that social cognition implies shared motor representations; empathic skills; homeostatic processes linked to basic emotions and motor and visceral reactions; reward and motivational systems; and higher-level controlled processes involved in decision making, affective values, and the learning of semantic categories and norms (Beer & Ochsner, 2006; Lieberman, 2012; Todorov, Harris, & Fiske, 2006).

Gender differences in empathy and compassion indicate a more self-focused, intense experience and more diverse brain activity for women (Mercadillo et al., 2011; Moriguchi, Touroutoglou, Dickerson, & Barrett, 2013), attributable to both biologically differentiated attributes and learned cultural roles. Examples include the actions of hormones in neural circuits that are enhanced during maternal attachment and nurturing (Campbell, 2008; Lenzi et al., 2009) and sexually differentiated emotional concepts and socially permissible expressions in western cultures (Fischer, Rodriguez-Mosquera, van Vianen, & Manstead, 2004).

An alternative to study compassion from social neuroscience perspectives could imply a mixed-gender group experiencing a shared cultural context where elicitors of empathy and moral codes influence the individual's experience. The police force may be one group that fulfills such requirements, since it is a cultural group where individuals share specific activities, beliefs, life styles, and codes which differ from the rest of the society in order to perform authorized functions, including helping others and reducing and preventing harmful behaviors through subjective interpersonal processes (Miller, 2004; Suárez de Garay, 2010). In addition, empathy may curtail the expression of justice and aggressive actions manifested in policing (Arsenio & Lemerise, 2004; Murphy & Tyler, 2008).

From neuroimaging approaches, studies on police show that traumatic situations experienced by police officers affect brain activity in regions related to memory and decision making, such as the hippocampus, parahippocampus, and frontal cortex (Hennig-Fast et al., 2009; Lindauer, Booij, et al., 2004; Lindauer, Olff, van Meijel, Carlier, & Gersons, 2006; Lindauer, Vlieger, et al., 2004). Nevertheless, only a few studies have focused on the influence of police-culture dynamics on the neural basis of social cognition (Mercadillo & Barrios, 2011).

In this work we propose a gender perspective considering the police force as a cultural community that influence the brain function related to compassion. We assume that compassion involves moral and affective traits that are culturally molded, and that the police culture imposes similar cultural codes for men and women to react in situations of suffering. Therefore, contrary to gender differences reported in civilian samples, we expected similar gender experiences and behavioral attitudes related with compassion and empathy. Also, we expected no gender differences in the brain activity related to empathy and moral decisions. Particularly, we anticipated similar brain activation in insular and prefrontal cortex in both, female and male police officers.

GENERAL METHOD

Overview

Our research integrates three sequential studies using different disciplines and a sample of police officers who work in the Head of the Division of Public Safety of Nezahulacóyotl Municipality, Mexico. Through ethnographic analysis we categorized cognitive social and compassionate elements in the officers' day-to-day work. A psychometric measure evaluated officers' empathic and aggressive attitudes. We performed functional brain imaging to identify brain activity related to compassionate experiences and decisions using a design previously applied in Mexican samples (Mercadillo et al., 2011).

Protocol

The procedure was designed in accordance with the Ethical Principles proposed by the American

Psychological Association (2002), the Declaration of Helsinki, and the Ethical Code for Psychologists in Mexico (Sociedad Mexicana de Psicología, 2009). The protocol was approved by the Bioethical Committee of the Institute of Neurobiology, Universidad Nacional Autónoma de México, and was supervised by the Head of the Division of Public Safety of Nezahulacóyotl Municipality. Volunteers agreed to participate in a confidential manner after the nature of the research was described. No individual was paid for participation. No subject was taking any regular medication during any stage of the study.

STUDY 1. CULTURAL CONTEXT AND ETHNOGRAPHIC EXPLORATION

Ethnographic approaches are based on first-person reports and used to identify perceptions directly assumed by individuals in a given cultural group that share similar patterns, expressions, and perceptions of the world (D'Andrade, 2001). This approach is important in the case of the police culture since the officers' perceptions are not strictly congruent with institutional directions, and because officers directly perform the behavior expected by the institution (Donnelly & Shirk, 2010).

Method

We focused on a sample drawn from the 1850 police officers working for the Division of Public Safety in Nezahualcóyotl (DPS-N). Nezahualcóyotl constitutes one of the most populous municipalities in Mexico, encompassing an area of 63.44 km^2 and a population in 2005 of 1,140,000 inhabitants, most of whom are migrants from other regions of the country. Besides its high density, Nezahualcóyotl is one of the most violent and conflict-ridden regions in the Mexican Republic. The eastern border with Mexico City, which is a distinct federal entity, results in jurisdictional conflicts that complicate the control of criminal acts executed in both districts, furthering the complexity of making moral and legal decisions.

During a period of eight months we performed ethnographic observations of daily activities, and carried out semi-structured interviews with 45 police officers (30 men and 15 women). Using The Grounded Theory method based on symbolic interactionism (Charmaz, 2005), observations and interviews examined (1) attitudes and abilities that officers indicated were necessary for policing, (2) the way they learn those abilities, (3) the problems that influence their interpersonal relationships, and (4) the gender differences experienced by the officers themselves during their service. Records and interviews were analyzed weekly to categorize the main variables affecting the four general topics. Officers' statements were compared to the institutional information provided by the Psychological Support Unit of the DPS-N and the Police Academy.

Results and discussion

In agreement with the empathic and moral factors constituting the concept of compassion, police officers emphasized cooperativeness as an attitude linked to the notion of service, which is historically valued in police institutions. Officers expressed the necessity to develop abilities to infer the intentions and emotional states of others, to control impulsivity, and to follow norms and codes learned in the police force. These abilities are mostly learned during service and through the imitation of partners' attitudes, but they are not necessarily taught in the Academy. Similar to other studies, we found that empathy is considered to be a necessary trait to optimally execute the duties of a police officer (Aranda-Beltrán, Pando-Moreno, Salazar-Estrada, Torres-López, & Aldrete-Rodríguez, 2009; Maddox, Lee, & Barker, 2011; Suárez de Garay, 2006). Conversely, and as reported in other countries, aggressiveness was mentioned as an attitude required for self-protection in environments perceived as violent (Pancheri et al., 2002).

Gender differences indicated that women are perceived as more sensitive than men when experiencing adverse situations, and this perception influences the role of women in daily police dynamics (Rabe-Hemp, 2008). Institutional evaluations did not identify gender differences in empathy or aggressiveness, but indicated that civil society perceives police officers as aggressive and associates them with antisocial behaviors. The Psychological Support Unit informed us that police officers manifest a decreased level of empathic and affective expressions, and they develop their own mechanisms to regulate anger.

Table 1 summarizes the main empathic abilities and problems related to the concept of compassion. Some testimonials and complementary interpretations are presented in the Supplementary material. An in-depth ethnographic and psychosocial study of this police sample can be found in Mercadillo, Galindo, and Barrios (2012).

TABLE 1
Summary of the main abilities and problems related to the concept of compassion mentioned by police officers in Nezahualcóyotl during the ethnographic exploration

	Category	*Required for...*	*Learning*	*Gender differences*
Abilities	Cooperativeness	Cooperation between partners and help civilians	Perceived intrinsic attitudes to help others	No differences identified
	Empathy	Understand their partner's problems and the other's suffering and maintain respectful dialogues with civilians	Sensitive attitudes self-developed during practice	Women are perceived as more sensitive than men when facing suffering
	Morality and Service	Self-regulation and judgment of other's actions	Ethical codes of service and cooperation learned during training, during police practice, and inside the family	No differences identified
	Aggressiveness	Self-defense against dangerous people and situations	Perceived intrinsic attitudes or self-acquired during the policing practice	No differences identified
	Category	*Source*	*Resolution*	*Gender differences*
Problems	Hostility	Perceived injustice in the institutional hierarchy	No resolutions given	No differences identified
	Feminine dismissal	Masculine perception of police functions and rejection of attitudes perceived as feminine	Women adopt a masculine self-perception in the police department related to aggressive and non-sensitive attitudes	This item was mentioned only by women
	Risky situations	Risk of suffering or death when facing offenders or dangerous situations	Religious beliefs, trust between partners, and self-confidence when using arms	No differences identified

STUDY 2. PSYCHOMETRIC EVALUATION

Based on the relevant items resulting from the ethnographic exploration, we selected five instruments to measure empathy, aggressiveness, hostility, impulsivity, and dangerousness in a sample of 215 healthy police officers (77 women, 138 men; 33.72 ± 1.68 years old; 5.07 ± 2.53 years of active service, Min. = 3 years, Max. = 14 years). The sample included a proportional representation of the 12 hierarchical categories existing in the police force, ranging from officers to the commander-in-chief (Simple officer A = 20; Simple officer B = 56; Simple officer C = 80; Third officer = 10; Second officer = 10; First officer = 12; Sub-commander A = 6; Sub-commander B = 5; Sub-commander C = 4; Second commander = 4; First commander = 4; Commander-in-Chief = 4).

Method

Instruments

The five psychometric instruments were validated in Mexican samples and the Cronbach α coefficient was ≤ 0.50, verifying the reliability of each test.

The Interpersonal Reactivity Index (Davis, 1980; Pérez-Albéniz, de Paúl, Etxeberría, Paz-Montes, & Torres, 2003) evaluates dispositional empathy in four dimensions: Perspective Taking or the ability to adopt the other's point of view; Fantasy or tendency to empathize with fictional characters; Empathic Concern representing compassion for another's situations; Personal Distress or discomfort when witnessing others in aversive situations.

The Aggressiveness Test (Flores-Galaz, 1989) is based on the Choynowski Comprehensive Inventory (Choynowski, 1978), which evaluates aggressiveness as a propensity to fight and harm other people and is divided into six factors: Paranoia, Revenge, Self-control, Opposition, Verbal Aggressiveness, and Anxiety on Aggression.

The Impulsivity Test (Páez et al., 1996; Plutchik & van Praag, 1989) evaluates the tendency to make non-reflective decisions and execute risky actions.

The Buss-Durkee Hostility Inventory (Buss & Durkee, 1957; Oquendo et al., 2001) evaluates hostility as a multidimensional construct including cognitive, affective, and behavioral components observable in anger experiences, social beliefs, and attitudes

involving harming another person in a physical or verbal manner.

The Individual Criminological Response Index (Chargoy-Romero, 1993) evaluates dangerousness, considered as antisocial behaviors that affect people, material goods, and public social resources. It comprises seven factors: Aggressiveness, Egocentrism, Affective Indifference, Affective Weakness, Social Adaptation, Antisocial Tendencies, and Criminal Identification.

For a more detailed psychometric explanation of the test and the procedure, see the Supplementary material.

Statistical analysis

We obtained the mean of the ratings that determine the total score and factors of each instrument by using SPSS 15.0 software. Student's *t*-test for independent samples were executed to compare male and female ratings to identify gender differences. Pearson's correlations between the factors included in the Interpersonal Reactivity Index and the test measuring aggressiveness and related constructs were calculated. Linear regression analyses were obtained to identify empathic dimensions as predictors of aggressiveness, dangerousness, hostility, and impulsivity. Scores for the Interpersonal Reactivity Index factors were also correlated with the years of active service and the rank of police hierarchy.

Results

No gender differences were found for the Interpersonal Reactivity Index (see Table 2), for the Plutchik Test of Impulsivity (all subjects = 13.28 ± 3.66; women = 13.50 ± 3.98; men = 13.16 ± 3.49), and for the Buss-Durkee Hostility Inventory (all subjects = 27.31 ± 11.14; women = 27.64 ± 10.81; men = 27.14 ± 11.35).

TABLE 2
Mean ratings and standard deviation obtained for the dimensions included in the interpersonal reactivity index for all subjects, women, and men

	All subjects (n = 215)		*Women (n = 77)*		*Men (n = 138)*	
Dimension	*M*	*SD*	*M*	*SD*	*M*	*SD*
Perspective taking	2.38	.59	2.44	.57	2.34	.61
Fantasy	1.43	.75	1.41	.75	1.44	.75
Empathic concern	2.39	.67	2.50	.72	2.34	.65
Personal distress	1.19	.74	1.27	.72	1.14	.76

Note: Each dimension was measured on a 0-4 scale, where 0 represents that the statement "Does not describe me well" and 4 represents "Describes me very well".

TABLE 3
Mean ratings and standard deviation obtained for the factors included in the aggressiveness test for all subjects, women, and men

	All subjects (n = 215)		*Women (n = 77)*		*Men (n = 138)*	
Factor	*M*	*SD*	*M*	*SD*	*M*	*SD*
Paranoia	1.79	.60	1.79	.56	1.80	.62
Revenge	1.58	.48	1.57	.47	1.59	.59
Self-control	2.44	.50	2.45	.44	2.44	.53
Contradiction	1.66	.54	1.62	.52	1.69	.55
Anxiety on aggression*	1.93	.69	2.07	.74	1.85	.64
Verbal aggressiveness	2.55	.59	2.56	.66	2.54	.54

Notes: Each factor was measured on a 1–5 scale, where 1 represents that the statement "does not describe the person at all" and 5 indicates a completely accurate description of the individual's attitudes. * Indicates significant gender differences ($p \leq 0.05$) when the Student's *t*-test was applied.

Women reported significantly higher ratings in the Anxiety on Aggression factor of the Aggressiveness Test ($t_{213} = 2.25$, $p \leq .05$) and lower ratings in the Affective Indifference ($t_{213} = -2.08$, $p \leq .05$) and Social Adaptation ($t_{213} = -3.07$, $p \leq .05$) factors of the Criminological Individual Response Index (see Tables 3 and 4).

Only the Verbal Aggressiveness factor of the Aggressiveness Test and the Affective Indifference factor of the Criminological Individual Response Index did not present significant correlations with the empathic dimensions included in the Interpersonal Reactivity Index. The Perspective Taking and Personal Distress empathic dimensions predicted Aggressiveness (see Table 5) (for complementary tables see Supplementary material).

No significant correlations were found between the empathic factors and the years of active service or the rank in the police hierarchy.

Discussion

Gender differences have been proposed for empathic and aggressive expressions (Campbell & Muncer, 2008; Rueckert & Naybar, 2008; Schulte-Rüther, Markowitsch, Shah, Fink, & Piefke, 2008; Verona, Reed, Curtin, & Pole, 2007). The similar scores for both genders in this police sample may be attributable to comparable learned strategies and the inner dynamics of the police department that restrain the expressions of emotions similarly in women and men (Mearns & Mauch, 1998; Meffert et al., 2008; Pancheri et al., 2002).

TABLE 4
Mean ratings and standard deviation obtained for the factors included in the individual criminological response index for all subjects, women, and men

	Score		*All subjects (n = 215)*		*Women (n = 77)*		*Men (n = 138)*	
Factor	*Min*	*Max*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Criminal aggressiveness	21	84	39.66	11.17	39.32	11.55	39.85	10.99
Egocentrism	26	104	67.39	9.02	66.53	9.43	67.85	8.80
Affective indifference*	18	72	42.05	6.73	40.69	5.93	42.76	7.02
Affective weakness	21	84	46.84	7.92	46.56	8.96	46.99	7.35
Social adaptation*	19	76	49.92	7.26	47.79	6.43	51.08	7.44
Antisocial tendencies	16	64	33.21	6.34	33.13	7.14	33.25	5.92
Criminal identification	21	84	47.70	10.17	47.06	10.81	48.06	9.81

Note: * Indicates significant gender differences ($p \leq 0.05$) when the Student's *t*-test was applied.

TABLE 5
Summary of linear regression analysis for the empathic dimensions predicting aggressiveness, hostility, and impulsivity

	Aggressiveness and related constructs								
	Aggressiveness			*Hostility*			*Impulsivity*		
Predictors	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*B*
Perspective taking	−0.15*	0.05	−0.23	−0.15	1.59	−0.09	−0.39	1.42	0.06
Fantasy	0.00	0.04	0.06	3.47*	1.25	0.24	0.19	0.51	0.04
Empathic concern	0.00	0.04	0.09	0.46	1.42	0.03	1.24*	0.4	0.23
Personal distress	0.12*	0.04	0.20	1.75	1.77	0.11	0.65	0.38	0.13

Notes: $N = 215$. Aggressiveness: $R^2 = 0.12$; Hostility: $R^2 = 0.11$; Impulsivity: $R^2 = 0.12$. * Indicates significant prediction at $p \leq 0.05$.

Women obtained higher ratings than men only in the Anxiety on Aggression factor of the Aggressiveness Test, which agrees with reports suggesting more emotional reactive responses in women (Bradley, Codispoti, Sabatinelli, & Lang, 2001; Javela, Mercadillo, & Ramírez, 2008). Gender differences may be stronger in psychophysiological factors, such as anxiety, but are dissipated in cognitive-dependent factors, such as moral values characterized in police institutions (Arsenio & Lemerise, 2004; DeWall, Twenge, Gitter, & Baumeister, 2009).

The lower ratings for women in the Affective Indifference factor and the higher ratings for men in the Social Adaptation factor of the Individual Criminological Response Index agree with reports suggesting that suffering situations are a more intense affective experience for women, while men tend to execute helping behaviors based on learned moral and legal codes and tend to execute instrumental aggression (Bjorklund, 2003).

The lack of gender differences for the empathic factors assessed in the psychometric study contrast with the gender differences reported in the ethnographic exploration indicating that women are perceived as more sensitive than men when facing other's suffering. These results may be attributable to the different nature of data obtained in both approaches, but perhaps indicate that police culture regulate empathic attitudes psychometrically appraised while may not influence the conceptual components expressed in the ethnography.

The lack of correlations between the assessed empathic factors, the years of active service and the hierarchy may be due to the variability of data presented in the last two characteristics. Nevertheless, low levels of Perspective Taking and high levels of Personal Distress predicted Aggressiveness. Aggressive expressions may be regulated by empathic skills to infer psychological states and process aversive situations, such as the suffering or violence perceived by the officers in Nezahualcóyotl. The inhibitory influence of empathy on aggressiveness (Pagani, 2001) might involve the cognitive aspects of empathy, such as the Perspective Taking skill, related to social and moral values and attitudes linked with the notions of cooperation or service instilled in the police culture (Crowson & DeBacker, 2008).

STUDY 3. BRAIN FUNCTIONAL SCANNING

Twenty-four police officers were selected (12 women, 12 men; *M* age = 34 ± 1.2 years, with 5.48 ± 1.6 years of active police service), whose scores were representative of the mean scores obtained in each psychometric evaluation and who represented the main hierarchies of the police department. Participants were strongly right-handed as measured by the Edinburgh Handedness Inventory and were in good general health as confirmed by a clinical interview. The Mexican electronic version of the Symptom Check List 90 (González-Santos, Mercadillo, Graff, & Barrios, 2007), a psychiatric interview, and a conventional electroencephalographic protocol verified the absence of current mental and neurological disorders.

Method

Cognitive task

We applied two event-related series of 100 visual stimuli gathered from a validated set of pictures selected from the International Affective Picture System (Lang, Bradley, & Curberth, 2005) previously validated by our group for fMRI studies of compassion in Mexican samples (see Mercadillo, Barrios, & Díaz, 2007; Mercadillo et al., 2011). Two categories of stimuli were contrasted in each series by applying this event related design. For the Compassion-Objects series 14 compassion-evoking pictures that depicted suffering in different environments and situations (e.g., war scenes, sad facial expressions, famine situations, or people on poverty or in addiction situations representing some quotidian scenes manifested during the police officer's work) were alternated with neutral pictures representing objects and landscapes. Since compassion generally involves social elements, a Compassion-Social series of 14 compassion-eliciting pictures were alternated with emotionally neutral social pictures (e.g., people walking or waiting for the bus). Details for the cognitive design are presented in Figure 1. Information about the content and the emotional appraisals for each picture are presented in the Supplementary material.

Each series was presented in a separate functional run. Participants saw the stimuli through an Avotec MRI compatible visor (Avotec Inc. Stuart, FL) situated in front of their eyes. The presentation to all subjects was synchronized in the same manner by using the E-Prime software and Lumina response pads (Cedrus Co. San Pedro, CA and Psychology Software Tools, Inc. Pittsburg, PA). Participants were instructed to consider compassion as feelings of affliction caused by the perception of suffering in others that motivates to help the suffering party. By using the Lumina response pads, 12 of the participants (6 women, 6 men) were asked to press a button with their right index finger if they experienced compassion and a button with their left index finger in the absence of compassion while viewing each picture. The other 12 participants were asked to respond in the opposite manner. All participants practiced a mock series inside the scanner before the MRI session.

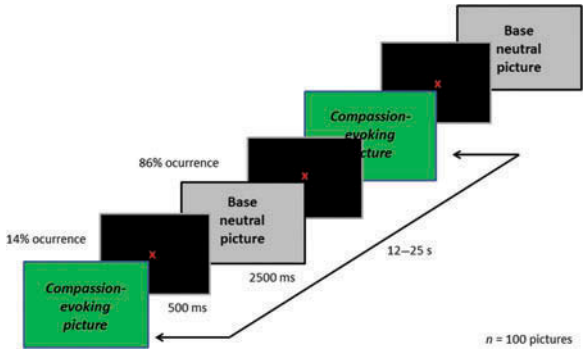

Figure 1. Event-related design applied in the presentation of visual stimuli. Two series consisted of 100 pictures: 14 compassion-eliciting pictures depicting suffering in several environments (stimuli of interest) and 86 neutral pictures (base stimuli). The Compassion-Objects series alternated compassion evoking pictures with pictures depicting objects and landscapes. The Compassionate-Social series alternated compassion evoking pictures with pictures depicting social common scenes. Each picture was presented for 2500 ms followed by a fixation cross 500 ms duration. Stimuli of interest were pseudo-randomly presented at 12–25 s intervals. The participants were asked to press a button with their index finger if they experienced compassion and a button with their left index finger in the absence of compassion while viewing each picture.

Functional image acquisition and analysis

Anatomical and functional sequences covering the whole brain were performed on a 3.0 Tesla Philips scanner at the Brain Images Department of the National Institute of Psychiatry in Mexico City. Anatomical images were acquired using a high resolution 3D SPGR (spoiled gradient sequence): 140 slices, TR = 24 ms, TE = 5 ms, flip angle = 30°, with 1 × 1 × 1 mm^3 resolution voxels. For the functional image acquisition a BOLD EPI-GRE sequence was applied: 30 slices, thickness = 5 mm, matrix: 4 × 4 mm^2, TR = 3000 ms, TE = 30 ms, flip angle = 90°, FOV = 24 cm. Data were transferred using DICOM format and were analyzed using SPM5

(Welcome Department of Imaging Neuroscience, http://www.fil.ion.ucl.ac.uk/spm/).

Pre-statistics image analysis included time slice correction, realignment for head movement, normalization for framing all the brain volume images into the MNI standard (Montreal Neurological Institute anatomical brain template), and spatial smoothing (Friston, 2007). One participant (male) was excluded due to excessive head movement.

We extracted from the E-Prime record the onset vector for each subject indicating the stimuli of interest distributed along the 100 time frames. The General Linear Model description matrix for each subject was defined using the recorded onsets vector with zero duration. Contrasts between conditions (compassion-evoking pictures *vs.* neutral pictures) were estimated at the first level statistical analysis for each subject. To estimate the average activation for all subjects in each functional series, a second level statistical analysis was applied with a one-sample *t*-Test using the first level contrast images of each subject. The same procedure was executed to estimate the average activation for women and for men. To contrast gender *vs.* gender we performed a second level, two-sample *t*-Test using the first level contrasts of females and males. Clustering was estimated by thresholding with the False Discovery Rate (FDR) correction at $p \leq .05$. A minimum threshold of 10 voxel set was considered for all cases. Cluster centroid coordinates of brain activation were estimated in SPM, and approximate location in Brodmann's area was acquired using the Talairach Deamon Client system (Lancaster et al., 2000).

Results

For the Compassion-Objects series all the participants showed activation in frontal and parietal cortical regions, limbic uncus, basal ganglia, and cerebellum. For the Compassion-Social series all the participants showed activation in the occipital cortex, parahippocampal gyrus, amygdala, and cerebellum (see Table 6 and Figure 2).

The brain activation averaged for men only in the Compassion-Object series was mainly identified in prefrontal, orbitofrontal, and parietal regions. Women only manifested activation in temporal regions, thalamus, and the cerebellar culmen. For the contrast between genders, women manifested significant activity in the frontal cortex,, insula, and thalamus. Men manifested activity in the visual associative cortex in Brodmann's area 18 (see Table 7 and Figures 3, 5).

Results for women only in the Compassion-Social series showed activation in bilateral parietal regions (Brodmann's area 7) and the parahippocampal gyrus. Men manifested activity in prefrontal (Brodmann's area 9, 46) and occipital (Brodmann's area 18,) regions.

TABLE 6
Activated brain regions for all participants identified by BOLD signal correlated with the experience of compassion while viewing pictures representing suffering alternated with pictures representing objects and landscapes (*Compassion-Objects series*) and pictures representing suffering alternated with pictures representing social common scenes (*Compassion-Social series*)

					MNI coordinates		
Anatomical region	*L/R*	*BA*	*Cluster size*	*Z value*	*x*	*y*	*Z*
Compassion-Objects series							
Middle Frontal Gyrus	R	6	38	4.53	42	10	54
Middle Frontal Gyrus	R	9	138	4.36	50	20	28
Middle Frontal Gyrus	R	46	14	4.01	54	34	18
Precuneus	R	31	17	4.13	28	−70	32
Uncus	R	28	64	4.39	34	6	−28
Lentiform Nucleus/Putamen	L	*	12	3.92	−22	10	−12
Caudate Nucleus	R	*	28	4.74	8	4	−8
Cerebellum/Posterior Lob. (Declive)	R	*	17661	5.86	10	−82	−10
Compassion -Social series							
Middle Occipital Gyrus	R	18	116	4.77	36	−92	8
Parahippocampal Gyrus	R	28	31	3.8	18	−2	−16
Amygdala	L	*	35	3.89	−18	−10	−18
Cerebellum/ Posterior Lob. (Declive)	L	*	128	4.39	−36	−80	−14
Cerebellum/ Posterior Lob. (Declive)	R	*	48	4.15	46	−66	−16
Cerebellum/Culmen	R	*	235	4.11	34	−42	−28

Notes: Results at $p < .05$ when False Discovery Rate correction was applied. BA = approximate Brodmann's area located by using the Talairach Deamon Client system.

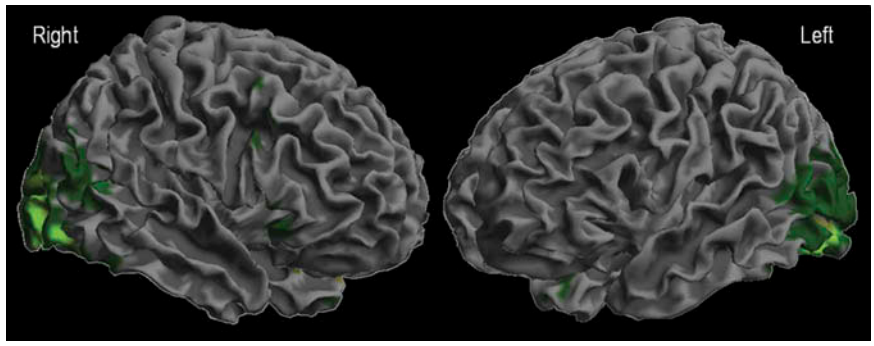

Figure 2. Render views representing the functional results for all subjects. Green: frontal (Brodmann's area 6, 9, 46), precuneus and cerebellar activation while viewing pictures depicting human suffering alternated with pictures showing objects and landscapes in the Compassion-Objects series. Yellow: occipital (Brodmann area 18) and cerebellar activation while viewing pictures depicting human suffering alternated with pictures showing common social scenes in the Compassion-Social series. Images illustrate the overlapping for the activation in the Declive located in the posterior lobule of the cerebellum in the two series according to the information presented in Table 6. Significant activation at $p < .05$ with False Discovery Rate correction.

For the contrast Women > Men, activation was identified in the cuneus and insula. The contrast Men > Women was null (see Table 8 and Figures 4, 5).

Discussion

The function of the prefrontal cortex in BA 9 is associated with attention and working-memory processes that communicate intentions (Frith, 2007) and identify one's own and another's emotional expressions (Bertoux et al., 2012) and pain (Benuzzi, Lui, Duzzi, Nichelli, & Porro, 2008), and it performs the moral reasoning (Raine & Yang, 2006) required for experiencing compassion. Only men showed activation in the orbitofrontal cortex (BA 47), which participates in the learning of moral values that influence the experience of moral emotions, such as indignation or shame (Moll et al., 2005; Takahashi et al., 2004). Conversely, only women manifested activity in BA 10 related to recognize the other's expressions as similar to those of the observer (Amodio & Frith, 2006). In addition, only women showed activation in the insula, which is essential for interoceptive information allowing empathy (Meltzoff, 2007; Mutschler, Reinbold, Wankerl, Seifritz, & Ball, 2013). Frontal activation for the Compassion-Social series was less than for the Compassion-Objects series, suggesting that cognitive processes required to analyze a compassionate situation are needed for general social scenes, not just those referring to suffering.

The activation of BA 31 in the superior parietal cortex observed in all the participants for the Compassion-Objects series has also been reported in studies of attention to emotional expressions and the elaboration of moral judgments (Benuzzi et al., 2008; Greene & Haidt, 2002), and it is thought to integrate unconscious conceptual information with one's own bodily representations (Soon, Brass, Heinze, & Haynes, 2008). These processes may be needed for social and compassionate decisions since they involve facial and body expressions of suffering inferred in another person. Activation of the precuneus in BA 7 observed only in women may suggest that females' analysis of the scene involves a more complex sensorial-associative process than that of men.

The parahippocampal gyrus was observed as active in both functional series and in both genders. Its function is linked to memory formation and spatial analysis of social environments (Axmacher, Schmitz, Weinreich, Elger, & Fell, 2008; Qin et al., 2009), so it may be required to integrate incoming information with episodic memory to judge the compassionate situation.

The dopaminergic role of the caudate nucleus and the putamen integrating the nucleus accumbens makes it important for the reward systems required to decide actions based on motivational and affective outcomes (Delgado, 2007). The activation of this region may be related to motivational notions of cooperation and service mentioned by the police officers in ethnographic exploration. The function of this region has been associated with feelings of love and attachment (Aron, 2005; Bartels & Zeki, 2004) and was observed only in women in the gender *vs.* gender contrast, supporting a more intense affective-reward process in female officers.

The role of the amygdala in aversive and pleasure behaviors has been reported for the recognition of one's own and others' emotions, and its diverse

TABLE 7
Activated brain regions for Women and Men identified by BOLD signal correlated with the experience of compassion while viewing pictures representing suffering alternated with pictures representing objects and landscapes in the Compassion-Objects series

					MNI coordinates		
Anatomical region	*L/R*	*BA*	*Cluster size*	*Z value*	*X*	*y*	*Z*
Only Women							
Superior Frontal Gyrus	R	6	107	4.36	20	4	72
Middle Frontal Gyrus	R	9	24	3.13	50	18	30
Superior Temporal Gyrus	R	22	14	3.3	48	−26	−12
Superior Temporal Gyrus	R	38	365	4.22	34	14	−42
Superior Temporal Gyrus	L	38	38	3.58	−38	14	−40
Superior Temporal Gyrus	R	39	328	4.3	52	−52	12
Cuneus	L	23	442	3.82	−4	−72	16
Insula	R	13	23	3.23	44	0	22
Thalamus	R	*	495	4.33	28	−32	−2
Thalamus	L	*	29	3.23	−20	−6	16
Caudate Nucleus	R	*	11	3.4	8	4	−8
Lentiform Nucleus/Putamen	R	*	13	3.27	24	20	6
Cerebellum/Culmen	R	*	48	3.6	6	−36	−30
Cerebellum/Culmen	L	*	9892	4.69	−40	−50	−32
Only Men							
Inferior Frontal Gyrus	R	47	339	3.77	50	26	−12
Inferior Frontal Gyrus	L	9	35	3.78	−56	26	24
Middle Frontal Gyrus	R	6	647	4.03	40	14	52
Medial Frontal Gyrus	L	9	32	3.34	0	46	18
Superior Frontal Gyrus	R	6	28	3.48	8	20	66
Superior Frontal Gyrus	R	8	1175	4.52	16	46	50
Precuneus	R	7	39	3.32	26	−58	58
Inferior Parietal Lobule	L	40	15	3.27	−36	−52	54
Superior Temporal Gyrus	L	22	81	3.31	−54	14	−4
Middle Occipital Gyrus	L	19	24414	5.88	−26	−90	20
Uncus	R	28	143	3.72	34	8	−28
Caudate Nucleus	R	*	163	4.28	8	4	−8
Cerebellum/Tonsil	R	*	98	3.74	18	−42	−48
Cerebellum/ Inf. Semi-Lunar Lob.	R	*	18	3.3	8	−76	−50
Women > Men							
Superior Frontal Gyrus	R	6	14	3.45	22	8	70
Medial Frontal Gyrus	R	10	30	3.48	18	48	2
Postcentral Gyrus	R	3	12	3.62	16	−30	76
Insula	R	13	11	3.31	44	0	22
Thalamus	R	*	55	3.49	4	−12	18
Men > Women							
Middle Occipital Gyrus	L	18	34	3.93	−26	−94	22
Substantia Nigra	L	*	22	3.92	−10	−18	−18

Notes: Results for the average of the brain activity for *Only Women* and for *Only Men* are significant at $p < .05$ when the False Discovery Rate correction was applied. Results for the second level contrasts for *Women > Men* and for *Men > Women* are significant at $p < .001$ with no correction. BA = approximate Brodmann's area located by using the Talairach Deamon Client system.

connectivity with brain centers regulating emotion and attention is fundamental for social cognition (Cunningham & Zelazo, 2007; Nummenmaa & Calder, 2009; Rolls, 2005). Activation of the amygdala was observed in the police officers, but not in civilians undergoing the same fMRI experiment (Mercadillo et al., 2011), which suggests that the police perform a more detailed analysis of the scene to accurately identify the emotional expressions.

Cerebellar activation was located in the vermis region, regarded as the limbic cerebellum where emotional expressions are regulated (Schmahmann, 1991; Tirapu-Ustárroz, Luna-Lario, Iglesias-Fernández, & Hernáez-Goñi, 2011). The cerebellum has also been reported to be active when individuals perceive either their own or another person's physical pain (Botvinick et al., 2005). Therefore, cerebellar function may allow an individual representation of physical pain influencing

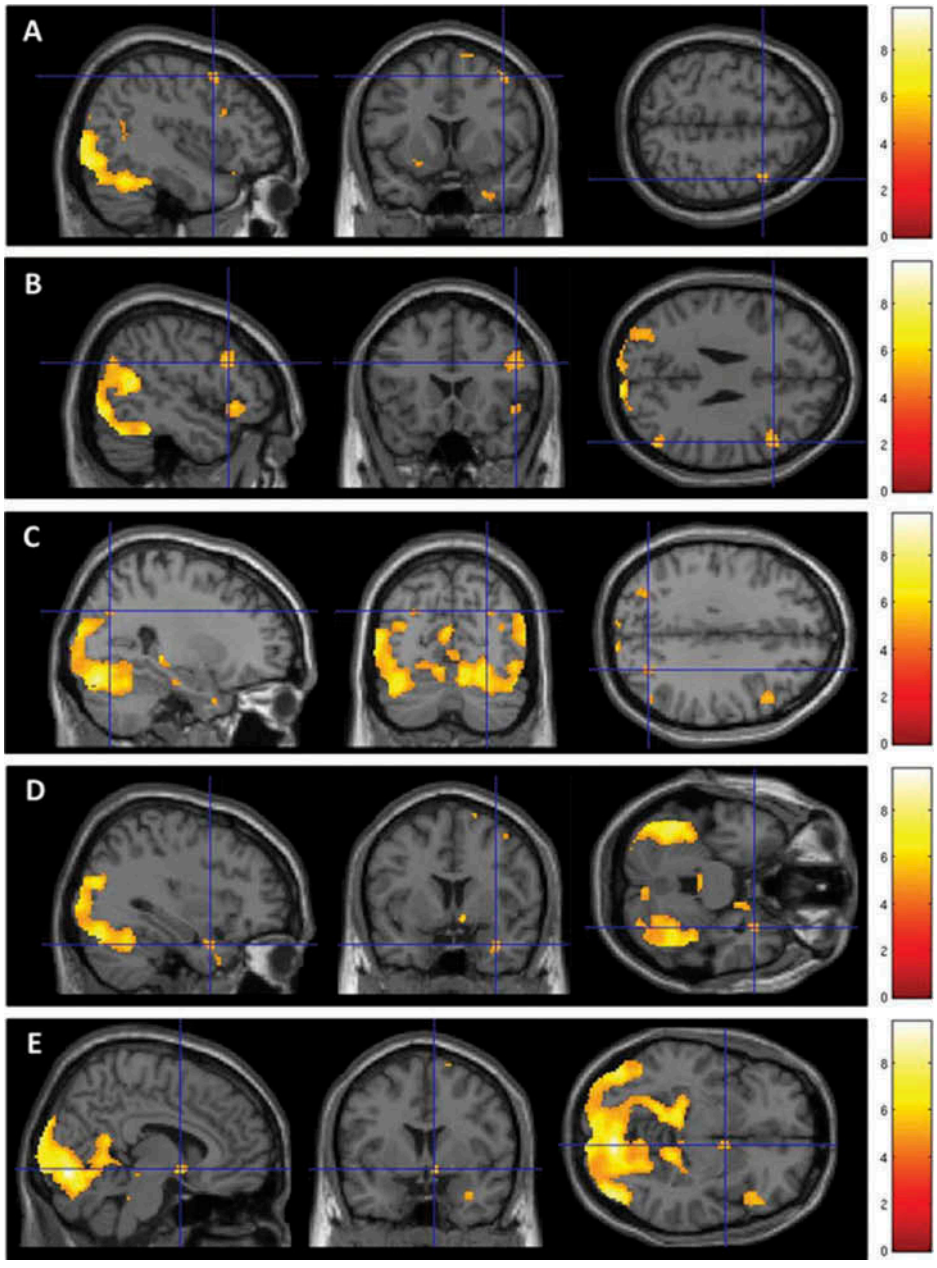

Figure 3. Functional results in sagittal, coronal and axial views representing cerebellar, cortical, and sub-lobar activation while subjects were viewing pictures depicting human suffering alternated with pictures showing objects and landscapes in the Compassion-Objects series. A. Frontal lobe (Brodmann's area 6 in blue coordinate). B. Prefrontal regions (Brodmann's area 9 in blue coordinate). C. Parietal lobe (precuneus in blue coordinate). D. Uncus (blue coordinate). E. Caudate nucleus (blue coordinate). Z value represented in the red-white bar. The False Discovery Rate correction was used with $p < .05$ in all cases. Blue coordinates indicate the cluster centroid according the MNI coordinates indicated in Table 6. Approximate Brodmann's area and brain region was obtained using the Talairach Deamond Client System.

empathy for the other's pain and necessary for compassionate decisions. This role is executed within a network comprising frontal and prefrontal regions, basal ganglia, and the parahippocampal gyrus related to motor decisions, working memory, and processing of moral values (Elsinger, Harrington, & Rao, 2006; Jahanshahi, Jones, Dirnberger, & Frith, 2006; Taniwaki et al., 2003) required for empathy, for the inference of motor states, and for intentional helping decisions contained in compassion.

TABLE 8
Activated brain regions for Women and Men identified by BOLD signal correlated with the experience of compassion while viewing pictures representing suffering alternated with pictures representing common social scenes in the Compassion-Social series

					MNI coordinates		
Anatomical region	*L/R*	*BA*	*Cluster size*	*Z value*	*x*	*Y*	*Z*
Only Women							
Precuneus	R	7	11	3.32	30	−66	46
Precuneus	L	7	50	3.45	−30	−44	44
Middle Occipital Gyrus	R	18	160	3.68	34	−92	8
Parahippocampal Gyrus	R	34	90	3.54	24	4	−24
Parahippocampal Gyrus	L	28	36	3.42	−22	−30	−10
Cerebellum/Culmen	R	*	415	4.07	36	−38	−24
Cerebellum/Culmen	L	*	41	3.37	−26	−46	−18
Cerebellum/Declive	L	*	124	3.81	−34	−84	−14
Only Men							
Inferior Frontal Gyrus	R	46	11	3.32	52	36	6
Medial Frontal Gyrus	L	9	11	3.3	−2	46	24
Middle Occipital Gyrus	R	18	81	4.31	36	−92	10
Cerebellum/Posterior Lob. (Declive)	L	*	13	3.26	−40	−74	−14
Women > Men							
Cuneus	R	19	14	3.85	10	−84	40
Insula	R	13	19	3.44	48	10	−14
Men > Women							
				Null			

Notes: Results for the average of the brain activity for *Only Women* and for *Only Men* are significant at $p < .05$ when the False Discovery Rate correction was applied. Results for the second level contrast *Women > Men* are significant at $p < .001$ with no correction. BA = approximate Brodmann's area located by using the Talairach Deamon Client system.

SUMMARY AND CONCLUDING DISCUSSION

Compassion involves a variety of interpersonal behaviors associated with altruism, empathy, and appraisals mirroring pain, sadness, or fear, and the neurocognitive function regulating these behaviors can be culturally influenced (Goetz, Keltner, & Simon-Thomas, 2010; Mercadillo & Arias, 2010). For example, exposure to violent environments, such as those that occur in the Nezahualcóyotl Municipality, has been reported to decrease the insular activity related to empathy for another's pain (Guo et al., 2013). Nevertheless, as observed in the ethnographic analysis, empathy is considered by the officers as an ability fundamental to policing in Nezahualcóyotl.

Since empathic expressions of compassion may be influenced by moral values homogenized for men and women in the police culture, we expected no gender differences in our sample. However, different frontal activation was identified between genders, and women but not men showed insular activation, which agrees with neurobiological and behavioral studies attributing to women more empathic expressions that influence moral judgments in suffering situations. Also, gender differences were detected at the ethnographic level, attributing more emotional sensitivity to women. At the psychometrical level men showed higher scores of social adaption, but no gender differences were observed for evaluations concerning empathic dimensions. These results indicate that specific cultural codes and regulative norms of the police institution might normalize the gender tendencies to execute explicit actions, as measured at the psychometric level, but may not modify the subjective experience or the cultural perceptions reflected in brain function and in ethnography.

The activity identified in the parietal, frontal, temporal, and cerebellar regions as well as in basal ganglia and insula agree with previous reports on the neurobiology of compassion (Immordino-Yang et al., 2009; Kédia et al., 2008; Kim et al., 2009; Lutz et al., 2008; Mercadillo et al., 2011; Moll et al., 2003, 2006). From the social neuroscience perspective assumed in our study, cognition can be considered as a biological process shaped through interpersonal and cultural interactions that integrate sets of codes and networks to allow collectivity, organization, multiplicity, and variability (D'Andrade, 2001; Wexler, 2006). In addition, from the interdisciplinary approaches we applied, the study of social brain functions can consider

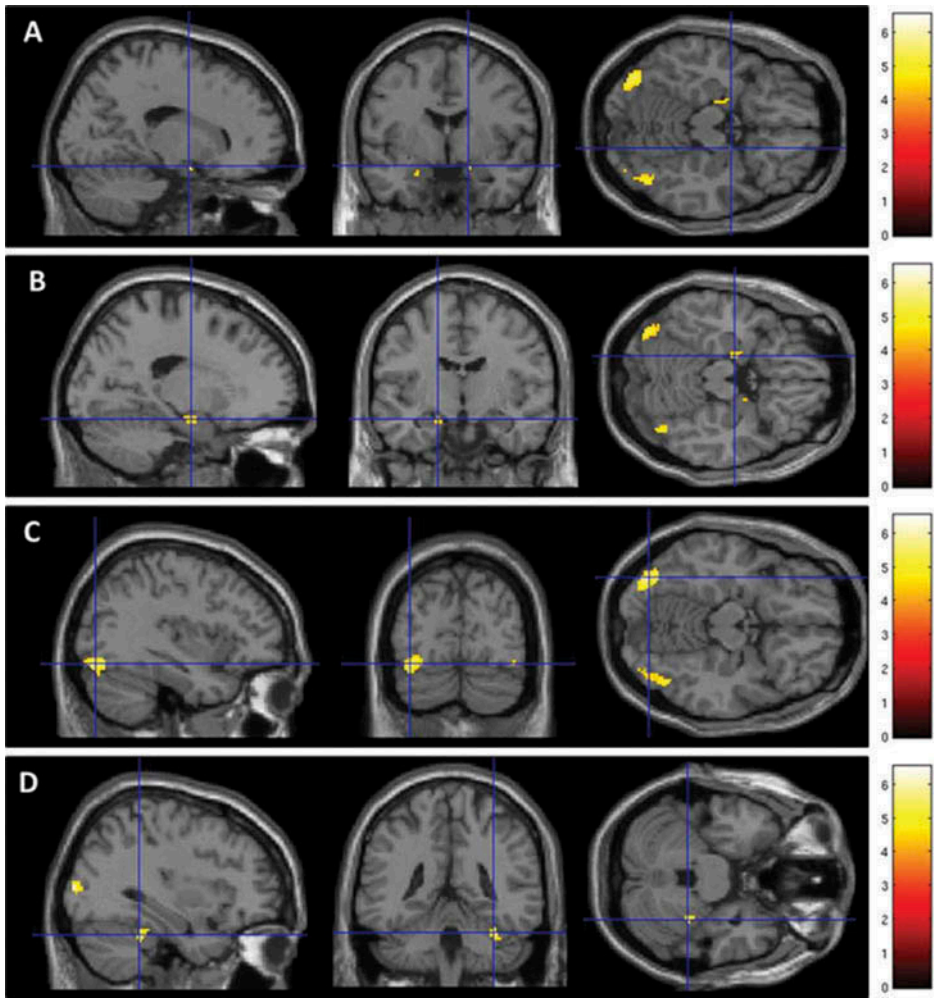

Figure 4. Functional results in sagittal, coronal and axial views representing cerebellar, cortical, and sub-lobar activation while subjects were viewing pictures depicting human suffering alternated with pictures showing common social scenes in the Compassion-Social series. A. Parahippocampal gyrus (Brodmann's area 28 in blue coordinate). B. Amygdala (blue coordinate). C. Cerebellar declive (blue coordinate). D. Cerebellar culmen (blue coordinate). Z value represented in the red-white bar .The False Discovery Rate correction was used with $p < .05$ in all cases. Blue coordinates indicate the cluster centroid according the MNI coordinates indicated in Table 6. Approximate Brodmann's area and brain region was obtained using the Talairach Deamond Client System.

experiential reports to be accurate portrayals of the participants' perception and history in an ecologically valid environment (Dominguez-Duque, Turner, Lewis, & Egan, 2010; Kanai & Rees, 2011). In this sense, the interpretation of some results observed in the police officers is noteworthy.

The amygdala plays a role in visual and emotional processes required for social interactions, for detecting suffering expressions, and for identifying aversive phenotypes in cultural contexts to regulate fear (Adolphs & Spezio, 2006; Bickart, Wright, Dautoff, Dickerson, & Barrett, 2011; Derntl et al., 2009). Unlike civilian samples, the activation of the amygdala in the police officers may imply that more complex visual and emotional processes are needed to perform more accurate empathic inferences related to the expressions of victims and offenders in an environment perceived as hostile.

The nucleus accumbens constitutes a functional group of neurons integrating part of the caudate nucleus and putamen observed in this study. This nucleus maintains indirect prefrontal projections favoring instrumental learning and motor decisions based on past experiences and expectations of rewards in the distant future (Rilling et al., 2002; Surmeier, 2013; Tricomi, Delgado, & Fiez, 2004). Compassion and pro-social tendencies are based on altruistic motivations influenced by cultural values, norms, and

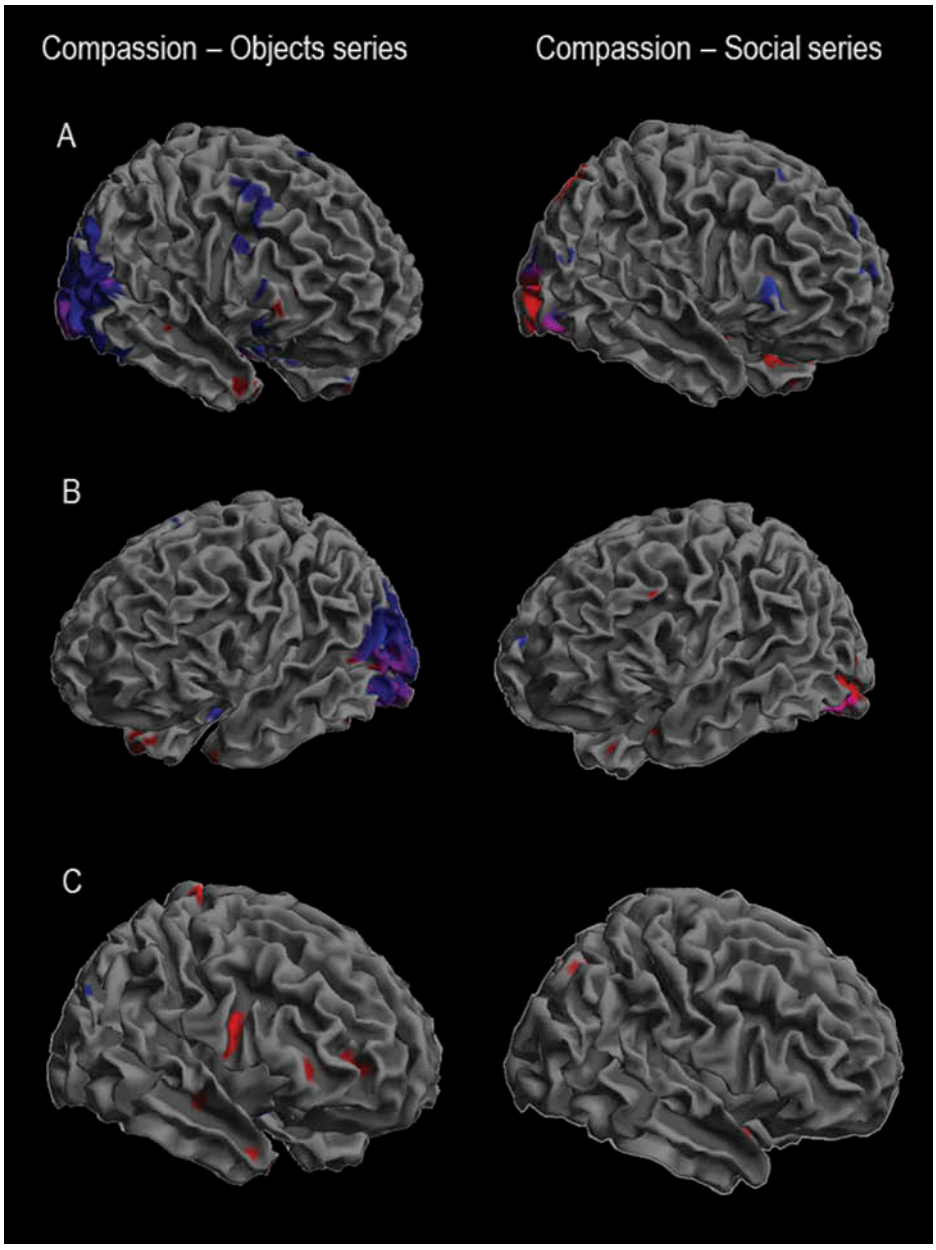

Figure 5. Render views representing the functional results for women (red) and men (blue) in the Compassion-Objects series alternating compassion evoking pictures with pictures depicting objects and landscapes, and in the Compassionate-Social series alternating compassion evoking pictures with pictures depicting social common scenes. Right lateral view (A) and left lateral view (B) showing results at $p < .05$ with False Discovery Rate correction. Results for the gender vs. gender contrast in each series (C). C-right side results for the Compassion-Objects series: women in right superior frontal gyrus, medial frontal gyrus, superior temporal gyrus, precentral gyrus and insula and for men in the left middle occipital gyrus; C-left side results for the Compassionate-Social series: women in the right cuneus and insula. Results for the gender vs. gender contrasts are significant at $p \leq .001$ with no correction. Results for the contrast Men vs. Women in the Compassion-Social series was null.

practices. The function of the caudate nucleus in the police officers may be part of a reward system motivated by cultural representations of service and altruism not present in civilians but learned through police practice, as was observed in the ethnography.

Projections from the cerebellar vermis to the interposed nucleus influence the regulation of fine movements and expressions of affective behaviors (Sacchetti, Baldi, Lorenzini, & Bucherelli, 2002) and, along with the striatum and the cerebral cortex,

may represent an emotional processor of motor expressions in social situations (Habas et al., 2009). These processes may be required in policing to infer the other person's suffering through sensorial mechanisms in order to create one's own motor and sensorial representations facilitating empathy and performing motor decisions to alleviate the suffering.

Both the elicitors and the expressions of compassion involve cultural variations to be considered when identifying human compassion-related brain patterns. These variations can be integrated into neurobiological research by using qualitative data extracted by ethnographical methods from different cultural samples.

Supplementary material

Supplementary content is available via the 'Supplementary' tab on the article's online page (http://dx.doi.org/10.1080/17470919.2014.977402).

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