Neuroscience and Ethnography: An Interdisciplinary Revision and a Cognitive Proposal based on Compassion Research in Mexico

Neurociencias y Etnografía: Una Revisión Interdisciplinaria y una Propuesta Cognitiva basada en Investigaciones sobre la Compasión en México

Review

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ABSTRACT

Social neuroscience considers the interplay of biologically evolved mechanisms and culturally shaped experiences as decisive to contextualize, motivate and influence complex brain functions and cognition. Compassion is a suitable moral emotion for approaching social cognition because it involves naturally and socially evolved factors to empathize with and wish to alleviate a perceived suffering of other individuals, and thereby promote social welfare. The present paper outlines research projects performed in Mexico, which focused on compassion from different viewpoints. The analysis includes psychometric evaluations of emotional appraisals, ethnographic records of Mayan populations, functional brain imaging with healthy Mexican individuals, including a sample of police officers', and theoretical analysis relating compassion and violence. We propose a threefold neurocognitive compassion system encompassing empathy, executive functions and memory. Also, we suggest applying ethnographic methods to design neuroimaging studies and thereby reveal and interpret brain functions among different social and cultural groups.

Key Words:
Compassion, Social neuroscience, Neuroimaging, Culture, Neuroethnography

RESUMEN

La neurociencia social sugiere que la cultura contextualiza, motiva e influye en la cognición y la función cerebral, e incluye la interacción de mecanismos biológicos adaptativos y de experiencias moldeadas culturalmente. La compasión es una emoción moral apropiada para comprender la cognición social, ya que involucra tanto factores biológicos como culturales para percibir el sufrimiento de otros y actuar por el bienestar social. Este artículo integra algunas investigaciones realizadas en México para estudiar la compasión utilizando evaluaciones psicométricas de experiencias emocionales, registros etnográficos en poblaciones mayas, el registro de la función cerebral en policías y análisis teóricos que vinculan la compasión con la violencia. Proponemos un sistema neurocognitivo triple de la compasión que involucra la empatía, funciones ejecutivas y memoria. También planteamos el uso de métodos etnográficos para diseñar estudios de neuroimagen e interpretar la función cerebral de grupos particulares.

Palabras Clave:
Compasión, Neurociencia social, Neuroimagen, Cultura, Neuroetnografía

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1. SOCIAL NEUROSCIENCE AND COMPASSION

During the last decade, several evolutionary, psychosocial and cognitive proposals have been highlighted and developed in neuroscience, particularly those concerning the social brain in the 1980's and 90's (i.e. see Cacioppo & Berntson, 1992; Dunbar, 1992; Gazzaniga, 1985). Such emphasis and expansion have been progressively manifested in the social neuroscience approach which considers that social dynamics contextualize, motivate and influence cognition, emotion and brain functions resulting in a variety of symbolic and inter-subjective interactions represented in social behavior. Consequently, social neuroscientific studies of human brain function, cognition and behavior are usually comparative because similar circumstances usually trigger diverse responses between different groups of individuals (Beer & Ochsner, 2006; Grande-García, 2009; Todorov, Harris, & Fiske, 2006).

Theoretical proposals, neuroimaging experimental research, and clinical observations allow researchers to interfere with human social cognition in relation to an individual's own motor representations, as well as in relation to others', which are regulated by the mirror neuron system and also introspective processes controlled by motor and prefrontal regions, as well as by cingulate and insular cortices (Mercadillo, Trujillo, Sanchez-Cortazar, & Barrios, 2012; Rizzolatti & Fabbri-Destro, 2008). Additionally, social cognition involves homeostatic, autonomous and emotional reactions, and top-down controlled processes involving intentions, decision-making, conscious affective evaluations, episodic memory, learning semantic categories, moral and ethical values, and norms (Adolphs, 2009; de Quervain et al., 2004). The striatal nucleus and reward systems are also essential to motivate and associate the individual's and the other's welfare in cooperative behaviors (Rilling et al., 2002).

The complexity of social cognition and behavior involves the interplay of both biologically evolved mechanisms and culturally shaped experiences (Ojeda & Mercadillo, 2007). Biological and behavioral results in primatology, ethology, ecology and evolutionary psychology suggest that basic and flexible neurocognitive systems such as learning, memory or perception have been naturally selected to process specific physical and social environmental information (Buss, 1999; Mercadillo, 2006). On the other hand, cultural perspectives consider that patterns of beliefs, emotions, practices, speeches, and conventional forms of interpersonal relations influence cognition and organize behavior according to the particular history of individuals and groups (Brewer, 2004; Wexler, 2006).

Compassion constitutes a momentous theme to approach and understand social cognition since the feeling and expression of this moral emotion comprehends the interplay of naturally and culturally evolved factors. Indeed, moral emotions can be assumed as significant expressions of human social cognition since these secondary emotions depend on both a moral judgment and empathy influenced by personality traits. For example, tolerance and responsibility arise from perceived social transgressions, and are elicited by witnessing implicit or explicit violations of social norms that have been encoded in the agent's attitudes and beliefs (Mudrack, 2006; Nichols, 2002).

In this sense, compassion can be considered a prototypical moral emotion since it is elicited by observing the suffering of others. It entails keen feelings of empathy and hope of alleviating such perceived affliction, and motivates prosocial actions that promote the victim's safety and ultimately public welfare (Haidt, 2003; Mercadillo, Díaz, & Barrios, 2007). Since prosocial actions tend to restore moral values that are perceived as disrupted or broken, compassion must be understood and discussed as a high-level psychosocial phenomenon that invokes a range of feelings and values such as empathy, benevolence, indignation, punishment, concepts of good and evil, justice and ideals, and the acceptance or denial of social obligations (Kagan, 2005).

Compassion has been confused with empathy, but, as we have seen, the latter is only a component of compassion specifically directed at infering, assuming and emulating the suffering of others in connection with derived feelings of sadness or distress (Carr, Iacoboni, Dubeau, Mazziotta, & Lenzi, 2003; Stürmer, Snyder, & Omoto, 2005). Compassion has also been confused with altruism, but the genetic or social benefits reported in parental and reciprocate altruism have not been found for compassion (Cartwright, 2001).

Diverse ethological observations of reconciliation, cooperation, emotional contagion, punishment, and social behaviors, led to the proposal that compassion may be an emotional, empathic, and adaptive system that evolved in human and non-human primates and gradually merged with culturally developed human morality (Flack & de Waal, 2000; Mercadillo, 2007). Furthermore, several paleo-anthropological findings of complex aiding behaviors show that compassion is an affective and cognitive capacity, which developed in recent stages of

hominid evolution and is closely associated with symbolic thinking and flexible neurocognitive functions (Dettwyler, 1990; Eccles, 1996).

In conformity with these evolutionary and behavioral proposals, neuroimaging results in healthy humans undergoing experimentally elicited compassion indicate that this moral emotion implicates brain functions related to empathy, theory of mind, decision-making, and motor processes regulated by the superior parietal, prefrontal and temporal regions, as well as cerebellum, basal ganglia, and insula. Neuroimaging designs to study compassion have included: pictures and oral narratives that depict or describe psychological and physical pain (Immordino-Yanga, McColla, Damasio, & Damasio, 2009; Kedia, Berthoz, Wessa, Hilton, & Martinot, 2008); having the subject read compassion-eliciting statements (Moll, de Oliveira-Souza, & Eslinger, 2003); asking the subject to discriminate between facial expressions denoting suffering and those that don't (Kim et al., 2009); subjects who practice Buddhist *metta* (loving-kindness) meditation (Lutz, Brefczynski-Lewis, Johnstone, & Davidson, 2008; Weng et al., 2013); and subjects undertaking charitable and generous decisions (Moll et al., 2006).

With this background in mind, in the following sections, we present a revision and interpretation of several studies performed in Mexico, which study compassion from an interdisciplinary social neuroscientific perspective. In the final sections, we propose a threefold neurocognitive system that regulates the emotional and the executive elements constituting compassion, and we reflect on the methodological and interdisciplinary approaches needed to appropriately explore the experienced cultural factors that shape neurobiological functions.

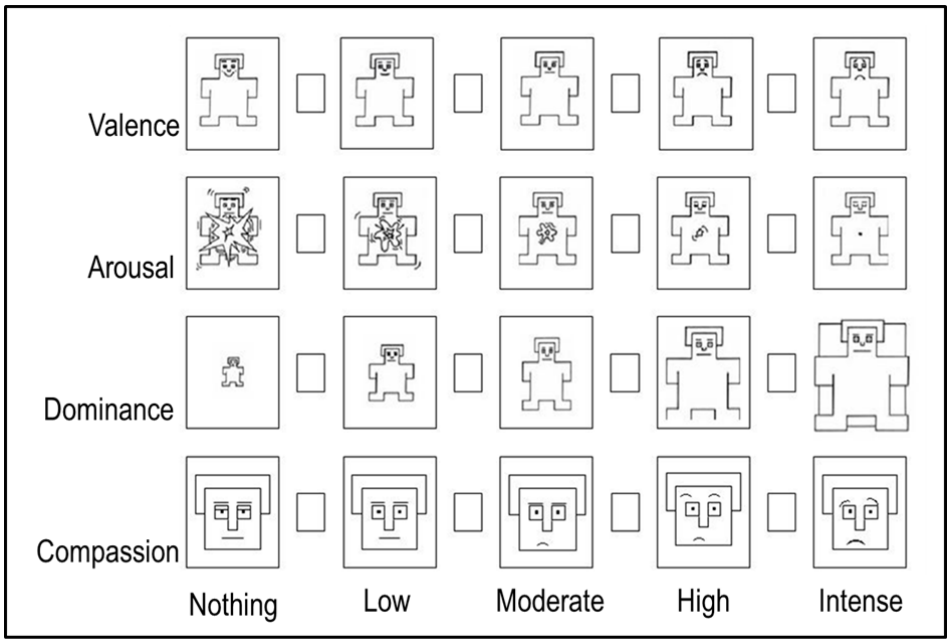
2. PSYCHOMETRIC DIMENSIONS OF COMPASSION-EVOKING STIMULI

Different terms are used to describe compassionate experiences in Spanish, and this variability frequently implies different intensities of the emotion, for example, *conmiseración* (commiseration) indicates a more profound experience than *piedad* (pity) (Díaz & Flores, 2001). In order to develop an experimental system to identify emotional, behavioral and neural dimensions of compassion, we initially performed a psychometric study with Mexican participants and performed transcultural comparisons using American, Spanish, and Brazilian data. Details of this work may be found in Mercadillo, Barrios and Diaz, (2007). Compassion was defined as "commiseration or affliction caused by the perception of suffering in others and motivates the viewer's desire to aid the suffering party". So as to obtain suitable compassion-eliciting stimuli a set of 84 pictures from the International Affective Picture System (IAPS) (Lang, Bradley, & Curberth, 2005) were selected for calibration using 60 Mexican volunteers. These images represented different states of suffering caused by moral or non-moral conditions in several social and non-social contexts. The IAPS calibration system measures the intensity of Valence, Arousal and Dominance dimensions for each picture using a Self-Assessment Manikin (SAM). We added a Compassion dimension qualified with a facial emblem from 0 (none) to 9 (maximal intensity) (see Figure 1).

Although compassion is clearly elicited by the perception of suffering in conditions of apparent conventional norm transgressions, the results indicated a moderate intensity of the emotion. The most intense compassion was reported by observing obvious expressions of physical pain during an injury or illness, and in general by facial and bodily expressions of sadness or pain in images that did not portray social contexts or norm violations. In addition, such intense compassionate experiences were correlated with low Valence (negative and aversive experience), and low Dominance (poor control of the image's emotional effect). These results indicated that compassion is a negative and rousing emotion that triggers communicational and adaptive expressions that display necessities and request for help from others. In this sample, Mexican men and women manifested similar feelings of compassion while observing the same pictures, but women manifested a higher intensity of the emotion. These results agree with reports suggesting that women manifest stronger empathic expressions (Fischer, Rodriguez Mosquera, van Vianen, & Manstead, 2004; Mestre, Samper, Frias, & Tur, 2009).

Valence, Arousal and Dominance manifested in American, Spanish, Brazilian, and Mexican samples were similar, but cultural differences were found in the intensity for each dimension when subjects viewed pictures representing suffering in social contexts and caused by norm violations (Lang et al., 2005; Larsen, Pompéia, & Amodeo, 2005; Moltó et al., 1999). These results suggest that morality associated with emotions is to some extent a cultural construct and promotes different relative valuations (Tilley, 2004); whereas some human manifestations of distress, such as facial expressions of pain, elicit similar emotional experiences in people from different cultures.

Figure 1.



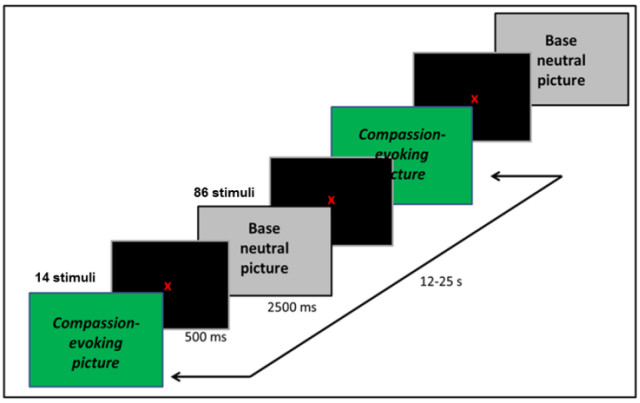
Self-Assessment Manikin system used to rate emotional appraisals while watching each picture. The system consists of a graphic figure paper-pencil responded and depicting nine values on a continuously varying scale for three dimensions: Valence, Arousal, and Dominance. A score of 9 represents the highest rating and a score of 1 the lowest rating on each dimension. A Compassion dimension and graphic was added depicting nine values. The Subjects selected any of the five figures from the four spaces between figures: 1 nothing, 3 low, 5 moderate, 7 high and 9 intense. Figure modified from Mercadillo, Barrios et al. (2007)

3. NEUROBIOLOGICAL SUBSTRATES OF COMPASSION EXPERIENCE: GENDER DISPARITIES

From the psychometric study, we selected a set of compassion-eliciting pictures suitable to be used in a Functional Magnetic Resonance Imaging (fMRI) study performed on groups of young (20-30 yrs) and healthy Mexican volunteers of both sexes. The aim of the study was to identify topographic brain activation elicited while the participants were watching each selected image or its proper controls and whether it led to a feeling of compassion (see Figure 2). Details of the fMRI design and analysis can be found in Mercadillo, Díaz, Pasaye and Barrios (2011).

Brain function results agreed with previous studies on compassion by showing significant activation in the prefrontal cortex (Brodmann's areas (BA) 47, 46), Broca's region, superior parietal (BA 7) and occipito-temporal cortices (BA 19), anterior cingulate cortex (BA 24, 32), insula, basal ganglia, parahippocampal gyrus, and cerebellum. Among many other functions, the insular, frontal and parietal regions contain the human mirror system, a neural network that may be necessary to integrate an experience of compassion since it probably shapes social interactions based on the inference of other's psychological states, feelings of empathy, and the representation of one's and other's body language (Pfeifer, Iacoboni, Mazziotta, & Dapretto, 2008; Rizzolatti & Fabbri-Destro, 2008; van der Gaag, Minderaa, & Keysers, 2007). In addition, prefrontal and anterior cingulate cortices play a role in basic cognitive processes, such as, attention and memory, but also in complex cognitive processing needed for decision making, motivation, emotional valuations, and moral judgment (Fuster, 2009; Greene, Nystrom, Engell, Darley, & Cohen, 2004; Posner, Rothbart, Sheese, & Tang, 2007). This set of basic and elaborate cognitive processes is probably required to decide what actions are needed to alleviate the suffering of others, motivated by socially learned moral values and by the individual's own aversive experiences.

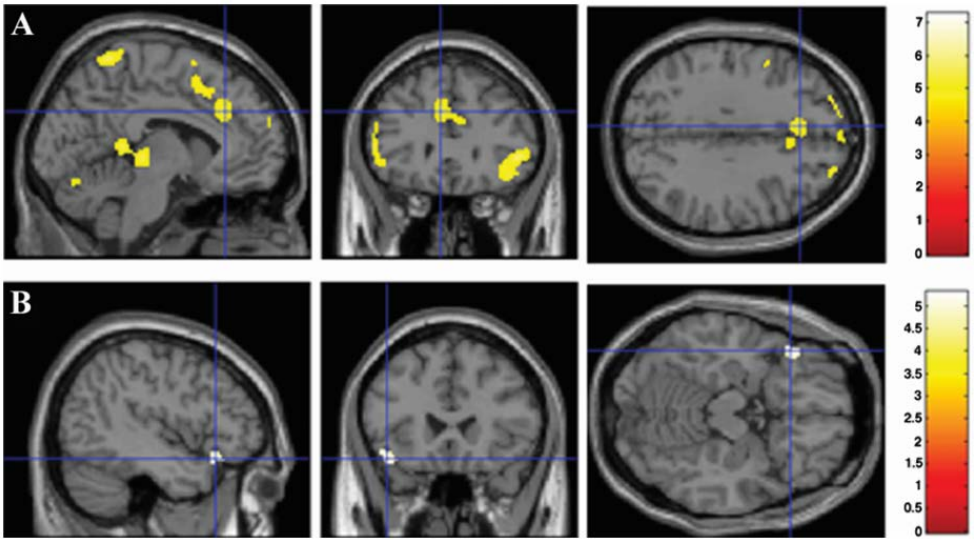
Figure 2.



Event-related design used to present pictures during the functional magnetic resonance scanning through a visual IFIS system compatible with MRI instruments and situated in front of the participant's eyes. The task consisted of 100 pictures: 14 compassion-evoking pictures depicting suffering in social contexts (stimuli of interest) and 86 neutral pictures representing common social scenes or objects (base stimuli). Each stimulus was presented for 2500 ms. The stimuli of interest were pseudo-randomly presented at 12-25 s intervals. Participants were asked to press a button using the IFIS system through a serial port executed by E-Prime and with their right index finger if they experienced a compassionate feeling, and a button with their left index finger in the absence of a compassionate feeling when viewing each picture. Figure modified from *Mercadillo et al., (2011)*

Although both women and men indicated similar compassion experiences while watching the selected pictures, important gender differences were found in their brain response. Women manifested a much wider activation involving superior parietal regions, insula, cingulate and frontal cortices, while men's activations were restricted to the orbitofrontal and para-hippocampal cortices (Mercadillo et al., 2011). These disparities between genders agree with other studies that show stronger emotional reactions in women when they experience empathy, watch aversive pictures, and analyze moral transgressions (Bradley et al., 2003; Javela, Mercadillo, & Ramirez, 2008). These differences may be explained by a convergence of biologically and socially evolved mechanisms since neurocognitive processes underlying compassion may have evolved differentially in association with the nurturing skills required for maternal tending and communication (Campbell, 2008; Lenzi et al., 2009), and can also result from culturally learned prospects and roles influencing moral judgments. For example, it has been substantiated that Mexican society strengthens empathic and caring expressions in women, considering them essentially "feminine", while simultaneously emphasizing conceptual and non-empathic moral evaluations in men (Díaz-Guerrero, 1994; Ramos-Lira & Saltijeral, 2008).

Figure 3.



Representation of the significant gender differences in brain activity observed with functional imaging while participants were viewing pictures depicting human suffering and indicating feelings of compassion. ***A*** *Brain activity for women in the right anterior cingulate cortex, left and right superior frontal gyrus, parietal cortex and cerebellum.* ***B*** *Brain activity for men in left inferior frontal gyrus. Details in Mercadillo et al., (2011).*

There is an intriguing contradiction between similar compassion experiences in men and women recorded with psychometric evaluations, and the differential brain activations revealed in the fMRI scanning. In order to answer the debates surrounding inconsistencies between physiological processes and subjective reports (Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005), it may be pertinent to consider that moral judgments may be reached unconsciously or intuitively before a clear and rational assessment of the situation is completed (Hauser, 2006). A detailed and refined phenomenological exploration of men and women's compassionate experience may show dissimilarities that are consistent with differential brain activations.

4. CULTURAL EXPRESSIONS OF COMPASSION IN MAYAN POPULATIONS

Compassion has a strong cultural component and thus must be examined and understood. Mexico is a privileged country for this purpose because more than 60 different native languages and cultures still exist within its territory. Cultural experiences of compassion are not readily accessible from psychometric or neuroimaging studies, and to properly approach them, it seemed necessary to apply ethnographic techniques. Ethnographic methodologies consider that individuals act on their environment according to their understanding of the environment's structure and elements. The meanings of these elements emerge from interactions with other people, are transformed through cultural interpretations, and are used to understand and tackle precise situations and problems (Charmaz, 2005).

In order to explore compassion and cooperative attitudes in some indigenous populations, a preliminary ethnographic study was conducted in the Maya village of Kiní, Yucatán, Mexico, inhabited by 1414 people (51.3% monolingual Spanish, 47.1% bilingual and 1.5% monolingual Maya). Semi-structured interviews about compassion-relevant perceptual, emotional and moral factors were performed while participants observed the highest-rated pictures in the psychometric study summarized above. Participant observation, field diaries and photographic recordings were also performed and obtained in public spaces, neighborhood meetings and schools, as well as during festivals and religious ceremonies. Details of the study and broader interpretations can be found in Mercadillo and Cervera (2013).

The study found that, in relation to perception and emotion, the expressions of sorrow or pain depicted in the pictorial stimuli that triggered a compassionate response, were constructed based on a global perception of suffering. Thus, the scenes in the pictures were interpreted through the characters' bodies or facial expressions and in terms of the moral reason behind said expressions. These are some answers to the question "what do you see in the photograph?" (our translation into English):

- "Poverty, sadness" (woman, 47 y.o.)
- "It is a child who is crying, I think that he has no food" (man, 53 y.o.)

Empathy constitutes an association between the perceived expressions and the person's own experience and assessments. For example:

- "Because I see suffering, I feel sadness" (woman, 13 y.o.)

Subjects interviewed often attributed a greater empathic capacity to women in situations of distress, and this capacity was related to what was perceived as a particular feminine strength allowing women to endure pain. For example:

- "Women care more for those who feel anguish… because women carry packages of up to 40 kg and women cooperate a lot… If my husband gets sick I help him" (woman, 62 y.o.)

Personal experiences that influence empathy involve a "like me" process and an expression of mutual recognition (Meltzoff, 2007). This leads to a derivative experience when observing another's suffering through an egocentric cognitive system based on the person's own experiences of distress. This is an answer to the question "what do you feel when you look at the picture?":

- "Sadness, nostalgia, pain. I don't like that kind of situation. I am hurt, it even makes me want to cry. I think that they are suffering because if not, they would not be crying." (woman, 27 y.o.)

In contrast to the separation of emotional and behavioral factors suggested in the Moral Emotions Theory (Haidt, 2003), a prosocial action was usually inserted in the Mayan subject's compassionate experience. This is another answer to the same question mentioned above:

- "Compassion. I would pick them up [the children] with love, the love of a mother and father… to share the few things I have… because as I am a mother, it hurts me to see a child who walks from here to there, with no place to rest, without love…" (woman, 62, y.o.)

There are no accurate terms to translate "compassion" or "emotion" into the Mayan language. An approximate equivalent is "óol", that may be translated as "heart." In traditional Mesoamerican cultures "heart" is not only the seat of consciousness, but an attribute that allows human beings to interact with the rest of the people in the surrounding world constituting a moral organ involving sensorial experience, willingness, and intention (Hanks, 1990; López-Austin, 1994). Although the term *compasión* (compassion) is used among Maya people as a linguistic adoption from Spanish, the participants' testimonies showed attributes linked to the well-being of the other. For example, these are some answers to the question "what is compassion?":

- "A feeling of wanting to help someone else, even though you may not know him. You simply see him and feel that you want to help" (man, 25 y.o.)

The motivation to help is reinforced by personal and social codes inserted in intrinsic experiences and family inculcation. For example, these are two answers to the question "where do you get the urge to help?"

- "In my mind. We are already born with it" (man, 65 y.o.)
- "My dad told me: daughter, when you cook beans, you must give part of the food to someone else, outside! We give food to poor people that arrive home… If we don't have money, we give them a loaf of bread or an egg. So, I also tell my children" (woman, 53 y.o.)

In this way, it seems that Maya morality safeguards the well-being of others and is implemented as an attitude instead of standards derived from the premise of "what ought to be". Both the act to harm other people and the omission to help are considered equivalent. Also, the notion of justice is more restorative than punitive according to the dichotomy suggested by Abarbanell and Hauser (2010).

These cultural traits of the Maya people reveal the importance of inter-subjective relationships built from childhood by privileging social responsibility (Mosier & Rogoff, 2003). Instead of the hierarchical and vertical system of educational institutions, Mayan families apply horizontal educational systems where the child is assigned responsibilities from an early age, and a strong respect for parents and grandparents as transmitters of knowledge is emphasized (Cervera & Méndez, 2006; Chavajay, 2006). This educational system contributes to the construction of a notion of equality that reinforces empathy and collective safeguarding, two major components of the compassion experience and response.

5. CULTURAL AND NEURAL EXPRESSIONS OF COMPASSION IN MEMBERS OF A POLICE PRECINCT

In agreement with current theoretical proposals, the revised results obtained from psychometric, neuroimaging and ethnographic techniques suggest that compassion involves complex cultural patterns that are implanted in human social relations, perceptions and beliefs, and that it also encompasses evolved potentials inscribed in the functional capacity of the brain. In order to discern the relative weight of each of these two central foundations for the experience of compassion, an experimental strategy capable of distinguishing between them must be developed and applied. Specifically, the abovementioned differential brain topography obtained in men and women reporting a compassion experience while they observed images of suffering may be due to biologically evolved or culturally learned factors.

To assess the interrelation between biological and cultural factors in compassion, we studied police force members as a relevant population since they adopt a uniform, as well as rigorous and protracted training, all of which result in similar expectations, attitudes, behaviors, and belief-systems. Thus, the police represents a cultural community that shares specific codes that differ from the rest of society and are based on inter-subjective dynamics; empathic and moral abilities that match compassionate components in terms of serving others; preventing harmful behaviors-, maintaining the welfare of society as a whole; and their inference in others' mental states to make moral judgments and apply legal premises (Donnelly & Shirk, 2010; Miller, 2004).

An ethnographic, psychometric, and fMRI brain imaging study was carried out in a group of male and female police officers working in Nezahualcóyotl, a violent municipality of the greater Mexico City metropolis. The ethnographic approach consisted in first-person reports that were acquired to identify cognitive elements in the officers' daily routine and in interviews about the necessities, problems, and gender differences manifested by the participants. Psychometric instruments were used to measure attitudes related to compassion, such as empathy, and contrasting behaviors, such as aggressiveness or violence. Finally, functional brain

images were obtained by applying the same fMRI design used in Mexican civil samples on a group of 12 male and 12 female police officers while they experienced compassion. Details of the methods and results can be found in Mercadillo (2012a), Mercadillo and Barrios (2011), and Mercadillo, Galindo and Barrios (2012).

In accordance with other reports (Aranda-Beltran, Pando-Moreno, Salazar-Estrada, Torres-Lopez, & Aldrete-Rodriguez, 2009; Maddox, Lee, & Barker, 2010; Suárez de Garay, 2010), police officers expressed that empathy and the inference in the intentions and emotional states of others are necessary, not only for efficient policing, but also to control impulsivity and aggressiveness in others. Even though such abilities are not taught in the Academy, they are considered intrinsic to the job and thought to be learned while performing their job by observing partner's attitudes, and they are reinforced by the notion of service historically represented in the police institution. For example:

- "A lot of individuals do not try to help others. They can't become officers. The main attitude you need is a desire to help others." (male officer, 33 y.o.)

Aggressiveness is considered a self-preservation skill in environments that are considered aversive and violent (Pancheri et al., 2002). For example:

- "Being in full uniform, it is implied, you become a thug's target. If you kill one of them you are done, outside and inside (of jail)" (female officer, 32 y.o.)

A general reflection is that female officers are more sensitive than men when facing aversive and distressing situations (Rabe-Hemp, 2008). For example:

- "A lot of men do not want to patrol with women because, as they say: 'they have to take care of us'. But they must understand that at the moment that you get in the police car it does not matter if you are a man or woman. Even female comrades do not understand this point and they do not want to drive the patrol car or to catch the thief. Look! There is only one female commander. Women do not need to be cared for, we only need our space and confidence" (female officer, 32 y.o.)

Despite these considerations, no gender difference was revealed in the psychometrically-measured empathic factor, suggesting that the codes used in the police institution homogenize attitudes in both genders. Also, even though aggressiveness was considered essential, no differences were found between police and civilian samples.

The fMRI brain activations observed in parietal, frontal, temporal and cerebellar regions analyses were similar to those reported for the Mexican civilian samples (Mercadillo et al., 2011) and other groups (Immordino-Yanga et al., 2009; Kedia et al., 2008; Kim et al., 2009; Lutz et al., 2008; Moll et al., 2006). Insular activation was manifested only in female officers, which suggests that the police institution may homogenize attitudes and behavior as psychometrically-measured, but does not homogenize the brain function or the social perception observed in the ethnography (see Figure 4).

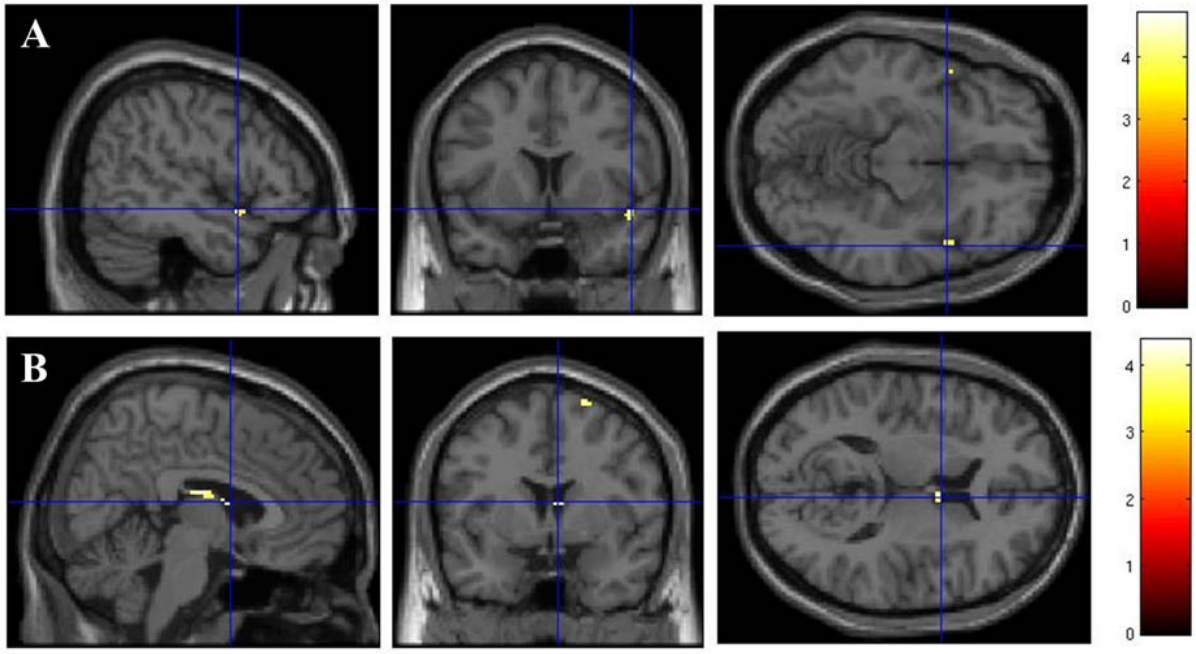
From social neuroscientific perspectives, the interpretation of the brain function can consider first-person statements in order to understand the participants' cultural perceptions in an ecologically valid environment (Varela & Shear, 1999; Wexler, 2006). In this sense, the activation of the caudate nucleus that is part of the long term reward systems (Tricomi, Delgado, & Fiez, 2004) was observed in the police officers but not in the civilian samples. This activation of the reward system may be stirred by learned expectations of service and altruism in police training and practice (see Figure 4). Moreover, police officers did not manifest activation in the anterior cingulate cortex, a region required to make complex decisions and reported in several studies on the neural basis of compassion. The lack of activity in this region has been observed in persons manifesting rigid and conservative thinking (Amodio, Jost, Master, & Yee, 2007) and may indicate that compassion and prosocial tendencies based on altruistic motivations are influenced by cultural values, norms and practices that may be indoctrinated.

6. A THREEFOLD NEUROCOGNITIVE SYSTEM UNDERLYING COMPASSION

Compassion should be considered in the wider framework of cooperative and peace-promoting behaviors that occur in opposition to aggressive and violent trends and manifestations (Mercadillo 2012b; Mercadillo & Arias, 2010). Moral values and behaviors manifested in human societies imply that there are certain aspects that have evolved and are shared with other animal species and codified in brain function providing an adaptation that probably increases the life-span period of the population. But, alongside moral behaviors, humans and other animal species display biological and emotional

arrangements allowing for aggressive responses (Cartwright, 2001). In the case of humans, some aggressive displays can be considered as violent when an intense damaging force is executed against others and falls outside of what is considered natural, moral or legal, an aggressive act that disturbs a natural state and breaks social and conventional rules (Diaz, 2010). Although compassion and violence represent opposite behaviors at the interpersonal and wider social level, both involve the participation of similar neurocognitive systems (Moya-Albiol, Herrero, & Bernal, 2010). For example, the insula, the anterior cingulate cortex and the prefrontal cortex which enable social learning, empathy, memory of emotional experiences, planning, control and decision-making are involved in both manifestations.

Figure 4.



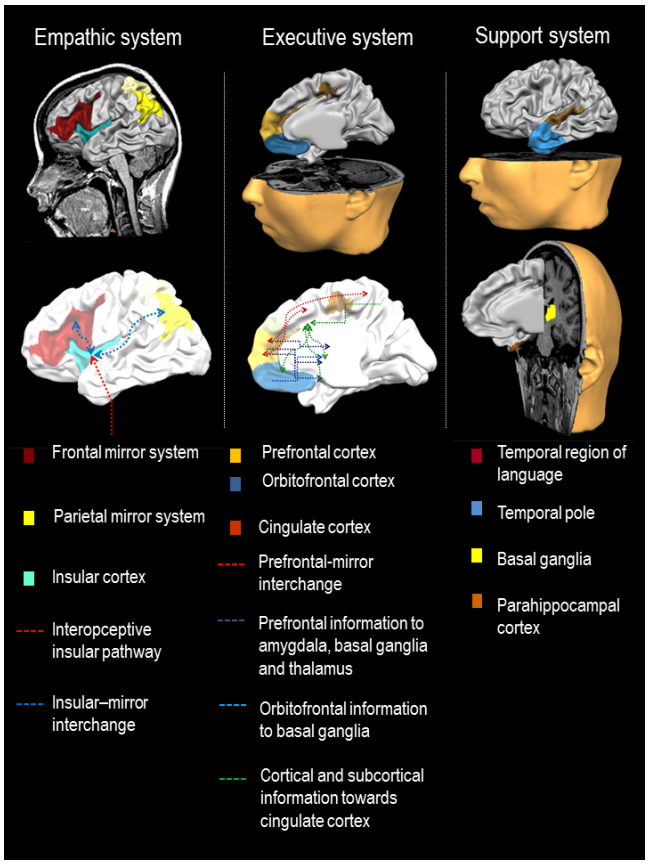
Representation of the brain activity observed with functional imaging while police officers were viewing pictures depicting human suffering and indicating feelings of compassion. A Activation in insular cortex observed for female officers (blue coordinate). B Activation of the caudate nucleus observed for all the officers (blue coordinate). Details in Mercadillo, (2012a).

Moral concepts vary according to the significant social experiences that each person codifies during extended life periods constructing individual morality in reference to sociocultural contexts (Shonkoff & Phillips, 2000). Thus, moral decisions stem not only from embodied experiences (Damasio, 2006) but may vary in reference to the person's understanding of compassion or violence, right or wrong, good or evil. The human neurocognitive system that processes social information concerning violent or compassionate behaviors and decisions is becoming increasingly clear, and is essential to understanding how information processing differs according to the cultural context where an individual was developed and to the perceived social needs that were covered.

Based on the investigations described above, we propose three interdependent neurocognitive systems underlying compassion in social contexts, (see Figure 5). The first one constitutes an Empathy System required to infer and grasp the psychological state of another individual. This system is distributed in the insula, frontal and parietal regions that exchange their local information through reciprocal projections and constitute the mirror of the neuron system (Rizzolatti & Sinigaglia, 2006). The insula integrates information from the spinal cord to represent the internal state of the body and the imbalance that is triggered from the perception of an aversive or unpleasant situation, as can be, in the case of compassion, others' pain or suffering (Mutschler, Reinbold, Wankerl, Seifritz, & Ball, 2013). The parietal cortex is thought to constitute a multimodal sensorial associative region to recreate the scene, while the frontal region participates in language production and motor functions, which may integrate interceptive information with movements and

expressions perceived in others and assimilated in the observer's body.

Figure 5. Representation of the hypothetical triple neurocognitive system regulating compassion.



The second neurocognitive system proposed for compassion is an Executive System that integrates motivational drives into decisions to help or alleviate the suffering party. This system involves the activity of the prefrontal, orbitofrontal and anterior cingulate cortices. The prefrontal cortex is associated with future planning and working memory, and it includes reciprocal projections to the frontal and parietal regions constituting the mirror neurons system; hence the empathic and executive elements of compassion are based on mnemonic information (Seitz, Nickel, & Azari, 2006). The prefrontal region includes thalamic projections that irradiate information throughout the cerebral cortex and basal ganglia regions that are involved in motivation and motor functions. In compassion this may lead to helping actions. The orbitofrontal region is linked to learning moral values and its projections include basal ganglia, particularly dopaminergic areas involved in reward systems. This interplay may be related to the motivation and pleasure associated with compassionate decisions as they are influenced by moral appraisals (Beer, Heerey, Keltner, Scabini, & Knight, 2003). The anterior cingulate cortex integrates information coming from frontal, temporal, and limbic regions involving the empathic, motivational, perceptual and motor functions required to make relevant decisions for the individual (Koski & Paus, 2000) as would be the decisions to help a suffering party, in the case of compassion,.

A third neurocognitive Support System does not directly participate in empathy or executive decisions, but provides information needed to carry them out, as occurs with semantic processes that outline the scene and the individual's experience. This system comprises temporal regions that process language comprehension and the categorization of social values imbued with emotional discernments, such as, honor or courage (Zahn et al., 2007). The support system also includes the amygdala, the basal ganglia participating in emotional valuations and motivation (Adolphs & Spezio, 2006), and the parahippocampal cortex needed for long-term memory storages and analyzing the spatial contexts where the perceived scene takes place (Axmacher, Schmitz, Weinreich, Elger, & Fell, 2008).

Therefore, compassion, as a social emotion involves homeostatic, empathic and altruistic reactions that are consistent with evolutionary approaches and are represented by activation in the insula and limbic structures (Goetz, Keltner, & Simon-Thomas, 2010). Compassion also integrates executive processes matching cultural attributions with their semantic meanings (Ratner, 2000). Such attributes explain the function of prefrontal and temporal brain regions, which associate linguistic categorization and understanding with the individual's moral emotions and judgments (Greene & Haidt, 2002; Zahn et al., 2007). Thus, to analyze compassion in the framework of social neuroscience one must consider that this moral emotion is cognitively organized.

This triple neurocognitive system of compassion is considered an integral part of the social brain allowing the individual not only to experience this complex moral emotion, but also to make predictions about the mental state and behavior of others and engage in meaningful and adaptive social situations (Frith, 2007). The functions of the neurocognitive system of compassion should be understood as embodied, systemic and self-organized since they operate in the sensory-motor exchange of information between the individual and a sector of the environment, namely a perceived suffering party (Washburn, 2006). The embodied and environmentally embedded organization allows for the compassionate experience and the subsequent

decisions and actions to take place. The complex organization of this moral emotion probably involves peripheral attributes or bodily markers for embodied and homeostatic functions (Damasio, 2006), and central cortical regulations of the emotional experience that allow learned reinforcements (rewards or punishments) to contribute to the formation of moral values (Rolls, 2005).

7. A NEUROETHNOGRAPHIC APPROACH TO STUDY BRAIN FUNCTION

Even though the object of social neuroscience mainly concerns cerebral anatomy and function, the field requires the gathering of extra-cerebral, behavioral and social information. The development of this interdisciplinary focus has shown that brain activity is profoundly modified and shaped by behavioral and extra-somatic interactions that occur in inter-subjective and cultural realms, and are able to establish and modify neuronal networks all along the development and consolidation of the brain (Shonkoff & Phillips, 2000; Wexler, 2006). The theoretical framework of social neuroscience should acknowledge that the experience of an individual does not solely depend on brain functions, even though these are obligatory for any mental experience to occur, but that the depositary and main actor of the experience is the individual and not any sub-personal system or mechanism. An important challenge is to understand how a crucial brain mechanism is systemically integrated into a personal experience such as compassion and how social stimuli shape and stimulate many neurocognitive and emotional functions. The personal level is represented by the individual as the "self," and this concept refers to the entirety of an organism including the biological, psychological, social, and cultural elements that are needed to integrate self-consciousness, and a contemplative higher mental capacity that allows for autobiographical narrations and ethical values to be questioned and defined (Díaz, 2007; Quinn, 2006).

The ethnographic approach constitutes a method of acquiring first-person knowledge to interpret life experiences, values, and worldviews of people in a given environment (Levine, 2003). Thus, an ethnographic approach focused on understanding emotions and morals of particular social groups, implies inter-subjective relations involving the researchers' empathic experiences. As presented in pioneering neuroanthropological proposals, culture implies psychological mechanisms that transmit and share information between people who possess biological needs (Domínguez-Duque, Lewis, Turner and Egan, 2009; Lende & Downey, 2012). Adopting an ethnographic method in social neuroscience would lead to interpreting brain function as an expression of particular variables of social life (Domínguez-Duque, Turner, Lewis and Egan, 2010). This may be the case of ethical principles that influence motivational brain functions in police officers, or gender differences in brain activity related to compassion.

As we observed in Mayan communities, ethnographic information can be categorized according to participants' historical, linguistic or behavioral meanings, and the researcher may act as a second-person translator between subjective first-person reports and third person objective measurements (Varela & Shear, 1999). If we consider this type of field data, brain structure and function may be interpreted not only at the level of a subject's cognitive processes, but also according to his or her social and ethnic characteristics. Taking into account cultural variables, such as beliefs, values and culturally-shaped experiences this interdisciplinary focus may become an essential factor for performing accurate cognitive tasks and neurobiological interpretations of social life.

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