

Brain Correlates of Impulsivity in Police Officers: A Neurocognitive and Ethnological Exploration

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Abstract: Police represents an institution that regulates the social welfare where the officers assimilate the behavioral codes to perform their functions. One of the problems identified in the police officer's behaviors refers to aggressive expressions, probably linked with impulsive reactions. In this report, we show an exploratory study to elucidate the neurocognitive correlation of impulsivity in a Mexican sample of police officers. These neural correlates were obtained during the execution of cognitive paradigms in functional magnetic resonance imaging. Brain functional data were complemented and interpreted through ethnological observations and psychometrical evaluations. Results suggest that the functional neurocognitive system regulating inhibitory reactions and impulsivity are based on moral and behavioral codes learned during the police training and practice. Aggression detected in this police department could be linked more with the perception of unfairness within the police organization but not with impulsive factors. Neurocognitive and ethnological approaches conform complementary strategies for more precise evaluation of aggressive expressions in police performance.

Keywords: Inhibition, attention, working memory, fMRI, prefrontal cortex, cingulate cortex, stroop task.

INTRODUCTION

Police represents an institution that regulates the social welfare where the officers assimilate the behavioral codes to perform this function. Absorption of these codes is based on neuro-cognitive processes elicited from the perception of a reality directly internalized by the police officer and relative to their cultural context in the police organization (Aguiar, 2006; Cruz, 2007; Terrill, Paoline, & Manning, 2003). Nevertheless, one focal problem identified in police samples concerns aggressive behaviors, meaning a series of actions directed to harm others usually connected with strong sympathetic activation and emotional experiences of anger or rage which in humans implies the idea of impulsivity (Ramírez, 2003; Ramírez & Andreu, 2006; Santos, Caeiro, Ferro, Albuquerque, & Luisa Figueira, 2006; Vaughn, Howard, & Delisi, 2008) in both normal and psychopathological individuals (Alcazar-Corcoles, Verdejo-Garcia, Bouso-Saiz, & Bezos-Saldana, 2010; Arce & Santisteban, 2006; Gansler, *et al.*, 2011).

Impulsivity is influenced by personality traits and individual developmental experiences that the officers most adapt in different physical and social conditions in order to respond to aggressive manifestations (Barth, Kellner, & Heinze, 2010; Cross, Copping, & Campbell, 2011; Upton, Bishara, Ahn, & Stout, 2011). Some studies have revealed that the situational stress is an aspect associated with decreasing communicational skills and with increasing experiences of anger and aggressive expressions in policemen

(Alexander & Walker, 1994; Mearns & Mauch, 1998; Mefert, *et al.*, 2008; Neylan, *et al.*, 2002; Pancheri, *et al.*, 2002; Ronald, Curtis, & Isaacs, 1994; Stuart, 2008). Anthropological perspectives in Mexico consider the police force a cultural group where individuals share specific life styles and codes in which the authorized function is helping others, reduce and prevent harmful situations and maintain the welfare of the society at large, based on moral and legal rules learned during a specialized training in order to acquire cognitive strategies to inhibit impulsive reactions (Azaola, 2006; Cruz, 2007; Suárez de Garay, 2006; Varela, 2007).

An alternative to identify a behavioral mechanism implicating impulsivity refers to the scanning of brain activity during the execution of cognitive a task concerning basic processes which indirectly require inhibition of impulsive reactions (Raichle, 2001). In this sense, working memory and selective attention constitute two basic cognitive processes related with social cognition and influenced by some factors presented in the police quotidian functions, for example in decisions making based on top-down processes of visual environmental and social cues (Scalf, Dux, & Marois, 2011). Working memory involves the integration of recent information necessary to perform decisions and to accomplish long term memory storages (Baddeley, 2003). In addition, prolonged stressful situations and sleep deprivation are common in the police line of work and could affect the working memory processes and inhibition of impulsivity regulated by frontal brain activity (Gohar, *et al.*, 2009; James, *et al.*, 2007).

On the other hand, selective attention enables better discrimination of relevant stimuli in the environment. Therefore, attention is related with several processes regulating behavior in a parallel manner, such as working memory,

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motivation, emotions and decision making. The neural networks regulating attention and inhibition involve prefrontal, parietal and cingulate cortices (Posner, Sheese, Odludas, & Tang, 2006). The function of these brain structures could be influenced by differences in the environment resulting in high continuous stress states reverberating in aggressive behaviors (Berkowitz, 2008). Under social neuroscience premises, real and hypothetic social and cultural situations are related to brain function (Todorov, Harris, & Fiske, 2006). Therefore, brain activity must be interpreted in conjunction with ethnological data that provides cultural and inner qualities of the individuals.

In this report we present an integrative pilot exploration to evaluate impulsivity in a sample of police officers and its relation with aggressive behaviors manifestations as was requested by their police department.

ETHNOGRAPHICAL EXPLORATION AND PSYCHOMETRICAL EVALUATION

From cultural-cognitive perspectives it is suggested that people in a group share similar codes and understandings of the world that are internalized during experience sharing. The ethnological approach based on first-person reports became relevant to identify some perceptions directly given by the individual who experience their cultural world (D'Andrade, 2001). In the case of police departments, this approach is relevant since some officer's perception about the policing dynamics is not essentially congruent with the institutional expectations (Campbell, 1995; Suárez de Garay, 2006).

The present study focuses on a sample of police officers working on the Division of Public Safety of Nezahualcōyotl Municipality which constitutes one of the most populous municipalities of Mexico, mostly conformed by migrants from other regions of the country. Social stress at Nezahualcōyotl City results in one of the most conflictive and violent regions in the Mexican Republic (Escalante, 2009). The eastern neighboring with Mexico City, which is a different federal entity, provokes jurisdictional conflicts that complicate the control of criminal acts executed in the limit of both entities furthering the complexity of legal decision making.

During a period of eight months, we performed ethnographic observations of daily activities and semi-structured interviews to officers referring attitudes and abilities that they consider as essential to implement their institutional line of duty, the way they learn them and their influence in the officer's interpersonal relations. Arguments provided by the participants and observations recorded in field were qualitative and linguistically categorized according the abilities they require and the difficulties they perceive. Officers' arguments were contrasted with the institutional information provided by Psychological Support Unit and the Police Academy.

In reference with impulsivity and aggression, officer's stands manifest the necessity to develop abilities and attitudes that help controlling the emotional and impulsivity reactions while following the police force norms. Cognitive and emotional abilities exposed by the officers are mostly learned by self-regulation during the service and through the imitation of partner's attitudes but not necessarily instructed at the Academy. Arguments about aggressiveness were generally mentioned in reference to interpersonal relations inside the Police Department but not in relation with the civilian

society and were linked with discomfort and perception of injustice concerning the institutional hierarchies. Also, impulsivity and aggressiveness were mentioned as required attitudes to maintain the self-safeguarding and reacting in dangerous situations in a violent perceived environment of Nezahualcōyotl.

Alternatively, officers mentioned that impulsivity is restrained by their sense of duty and attitudes of help conforming personal motives and the social representation of the police institution. Following, we present examples of some statements that illustrate the officer's point of view (English version implies a semantic translation without the colloquial speech used by the officers in Spanish):

You have to be crazy to be a police officer. You could see gunshots, detached heads, dead people and everything. Really, you have to be crazy, to be like animal (men, 31 years old).

[Para ser policía hay que estar medio loco, puede haber balazos, cabezas, muertos y de todo. En serio, hay que estar medio loco, ser medio animal]

To be in full dress uniform, implicate to be a thug's target. If you kill one of them you are done, outside and inside (of jail) (women, 32 years old).

[Estar uniformado es ser blanco de las ratas. Si matas a una no te la acabas afuera ni adentro (en la cárcel)]

They (chiefs) do not recognize your labor. It is unfair that they do not recognize your work in order to be a commander. We (basic officers) are who make the hard work (women, 35 years old).

[No te dan reconocimiento por antigüedad. Es injusto que no reconozcan tu trabajo para ser comandante; nosotros somos los que nos llevamos la friega]

A lot of individuals do not try to help others, they can not become officers. The main attitude you need is wishing for other's assistance (men, 33 years old).

[Hay muchas personas que no tratan de ayudar a los otros. Esos no pueden ser policías. Lo principal que necesitas es querer ayudar]

Based on the ethnographical data, we recruited two hundred and fifteen healthy police officers (77 women, 138 men; M age = 33.72 yr., SD = 1.68) representing the 12 institutional hierarchies, from officers to the commander-in-chief, as well as the mean of age, scholar education and period of active service presented in the Police Department. The absence of psychiatric and behavioral disorders was verified by the information provided by the Psychological Support Unit in the Police Department and through the application of the automated Mexican Version of the Symptom Check List 90. The procedure was designed according to the Ethical Principles of Psychologists and Code of Conduct proposed by the American Psychological Association (O'Donohue & Ferguson, 2003) and the Ethical Code for Psychologists in Mexico (Sociedad Mexicana de Psicología, 2009). The protocol was executed with the ethical supervision of the Direction of the Division of Public Safety and was approved by the Institutional Review Board of the Institute of Neurobiology of the Universidad Nacional Autónoma de México. Volunteers agreed to participate in anonymous and confidential

manner after the nature of the protocol was described and no individual was paid for his/her participation.

Participants completed a self-applied paper-pencil version of The Plutchik Impulsivity Test (Páez, *et al.*, 1996; Plutchik & Van Praag, 1989) which evaluates the tendency to make decisions in a non reflexive manner and execute risky actions. The test includes 15 items which could be rated in a range from 0 to 4, where "0" represents that the person never execute the actions presented in the statement and "4" represents actions always taken. A Cronbach's $\alpha = .76$ was observed in the reliability test.

A data base was created and statistical analyses were executed using the SPSS 15.0 software. Student *t* test for independent samples comparing male and female ratings were executed to identify gender differences in the responses.

Results showed a moderate score of impulsivity (13.28 ± 3.66) which is lower than the mean observed in the civilian samples (15.60 ± 5.5) when validated this instrument in Mexico (Páez *et al.* 1996). No gender differences were observed.

MATERIALS AND METHODOLOGY

Participants

Eight police officers (4 women, 4 men; 29 ± 3 years old) with seven years of service and representing the mean scores of the Plutchik Impulsivity test were selected from the psychometrical evaluation applied in the Police Department of the Nezahualcóyotl participated after informed written consent. The international neuropsychiatry interview-MINI and a clinical interview were applied to verify general health and the absence of mental and neurological disorders.

Cognitive Tasks

Two cognitive paradigms or tasks were designed in the E-prime software (Psychology Software Tools, Inc. Pittsburg PA.). One paradigm consisted in a version of the *Counting Stroop* task in Spanish language previously tested in Mexican samples (Mercadillo, Sánchez-Rey, Sánchez-Cortazar, Ramírez & Barrios, 2011). The *Stroop* paradigm is based in eliciting cognitive interference through the presentation of two categorically similar stimuli which force the individual to decide or select the relevant instruction; details in Fig. (1). The second paradigm consisted in a *N-Back* letter paradigm classically designed to measure working memory execution; details in Fig. (2).

Image Acquisition and Analysis

Anatomical and functional pulse sequences for whole brain were performed on a 3.0 Tesla Philips Achieva Scanner (Philips Medical Systems Eindhoven, NL) in the National Institute of Psychiatry. For the functional image acquisition a BOLD EPI-GRE (blood-oxygen level dependent EPI gradient echo) sequence was acquired over 30 slices, 5 mm thick slice with no gap and $4 \times 4 \text{ mm}^2$ in plane resolution; TR = 3000 ms, TE = 30 ms, flip angle = 90° , FOV = 24 cm. All fMRI data were transferred to offline workstations using DICOM format and all the image analysis was executed using SPM5 (Wellcome Department of Imaging Neuroscience, <http://www.fil.ion.ucl.ac.uk/spm/>).

The projection of the stimuli and the manual response were synchronized and extracted using the Lumina response system (Cedrus Co. San Pedro, CA). After acquisitions all images were transferred to an off line workstation with SPM 5 where they were: time sliced, realigned, spatially normalized and smoothed. Contrasts between conditions of interest were assessed with FWE correction with 0.05 level. The Talairach Daemon Client system (RIC, University of Texas Health Science Center) was used to acquire the specific Brodmann areas and region associated with the brain activity clusters.

RESULTS

During the Counting *Stroop* Task, brain activity was observed in left prefrontal cortex in Brodmann area (BA) 47 and bilateral corresponding with BA 9. Parietal activity was observed bilaterally in BA 40 while the temporal lobe was identified as active in the left Brodmann area 22. Occipital activation was identified in the *cuneus* corresponding with the Brodmann area 19. See Table 1 and Fig. (3).

While performing the N-Back paradigm, BOLD activations were identified in the left frontal cortex while corresponding with BA 44 and 47 and parietal in BA 7. Right BA 21 and left BA 22 were observed in temporal cortex and the *cuneus* in occipital region in BA 18.

DISCUSSION

Parietal and frontal activity identified during the Counting *Stroop* task could be related with the orienting and executive cognitive systems conforming the attentional network (Posner, *et al.*, 2006). Nevertheless, the lack of activation in the anterior cingulate (ACC) and orbitofrontal cortex associated with the attention processes and decision making may suggest differences between the police officers in comparison with healthy civilian reports while executing the Counting Stroop task (Bush, *et al.*, 1998; Bush, Whalen, Shin, & Rauch, 2006). The relevance of the ACC implies reciprocal neural connections with temporal and frontal regions related with semantic and motor processes, respectively, and with parietal regions linked with sensorial integration (Koski & Paus, 2000; Posner, Rothbart, Sheese, & Tang, 2007; Posner, *et al.*, 2006). Subsequently, ACC and orbitofrontal cortex functions are necessary to perform decisions and inhibit impulsive and aggressive behaviors (Adolphs, 2008; Nelson & Trainor, 2007).

Function of ACC is also related with cognition involving reward systems influenced by developmental experiences and social habit learning (Cohen, Dunbar, & McClelland, 1990; Mercadillo, Díaz & Barrios, 2007). As well, the lack of cingulate activity has been related with the presence of attention deficit disorder and impulsivity (Bush, *et al.*, 1999), nevertheless police officers did not manifest clinical symptoms linked with this disorder. Therefore, results may indicate the influence of inflexible decision making strategies learned during their police training and service, which has been similarly observed in people manifesting rigid opinions (Amodio, Jost, Master, & Yee, 2007).

On the other hand, prefrontal activation produced by the *N-Back* paradigm, results in processes related with decision making linked to working memory (Buckner, Kelley, & Petersen, 1999). Parietal activation may imply semantic and perceptual processes directed to analyze mnemonic stimuli

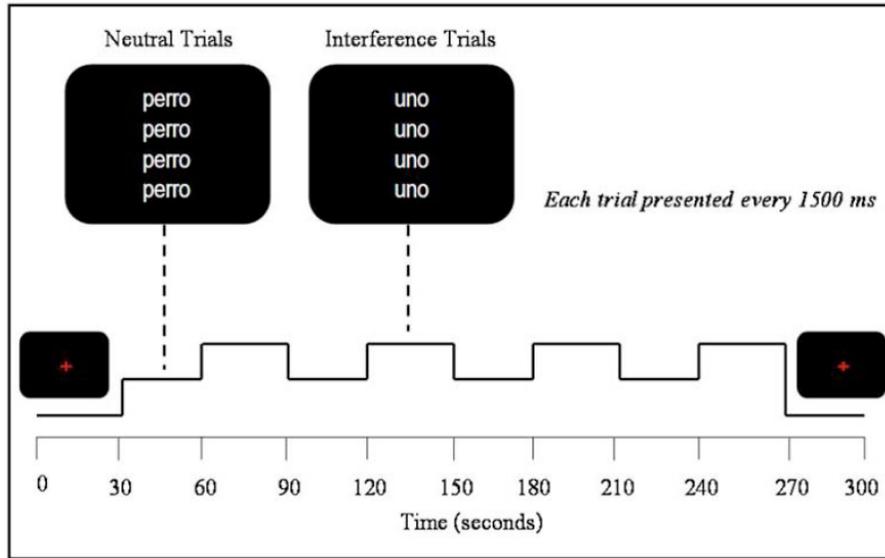


Fig. (1). Illustration of the block designed paradigm to assess the Counting *Stroop* Task. The task initiated with a fixation cross during 30 sec. Twenty *neutral* and *Interference* trials presented during 1500 ms were alternated in eight blocks with 30 sec. duration each. Neutral trials represented groups of words naming four animals: perro (dog), gato (cat), pájaro (bird) and ratón (mouse). Interference trials presented words naming numbers: uno (one), dos (two), tres (three) and cuatro (four). Each trial could be constituted by one, two, three or four words naming the same animal or number name. Participants were instructed to indicate the number of words presented in each trial and assessed the correct or incorrect answer by using the IFIS Response System (In Vivo Inc. Orlando FL) which consisted in two button settings collocated in index and middle fingers: Right middle (one), right index (two) left index (three) and left middle (four). For the example represented in this figure participant should indicate four words in both neural or interference trials by pressing the right middle finger. Task finalized with a fixation cross with 30 sec duration. Amount of correct responses were assessed in each participant.

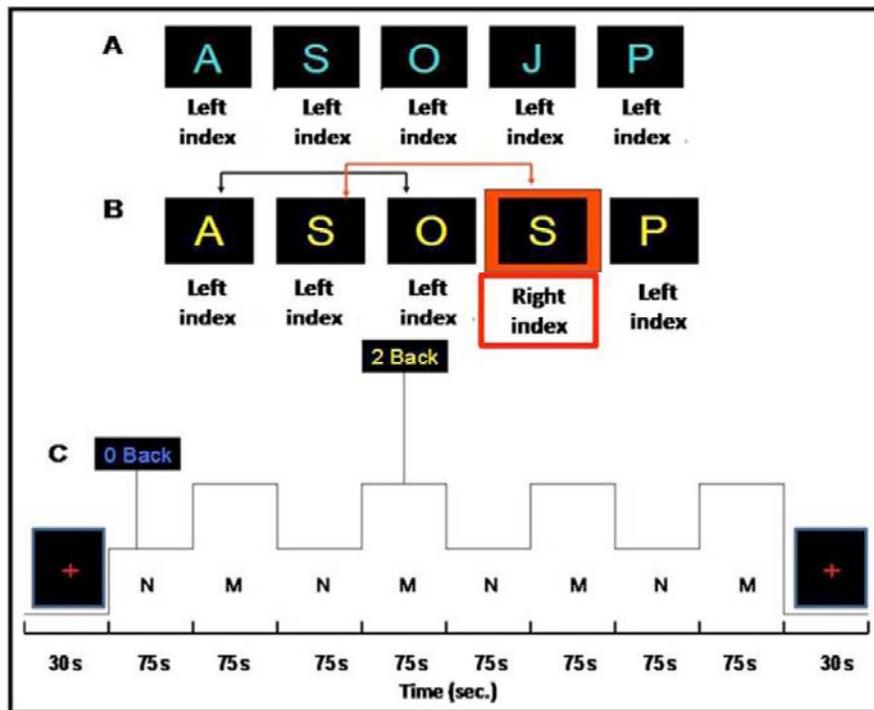
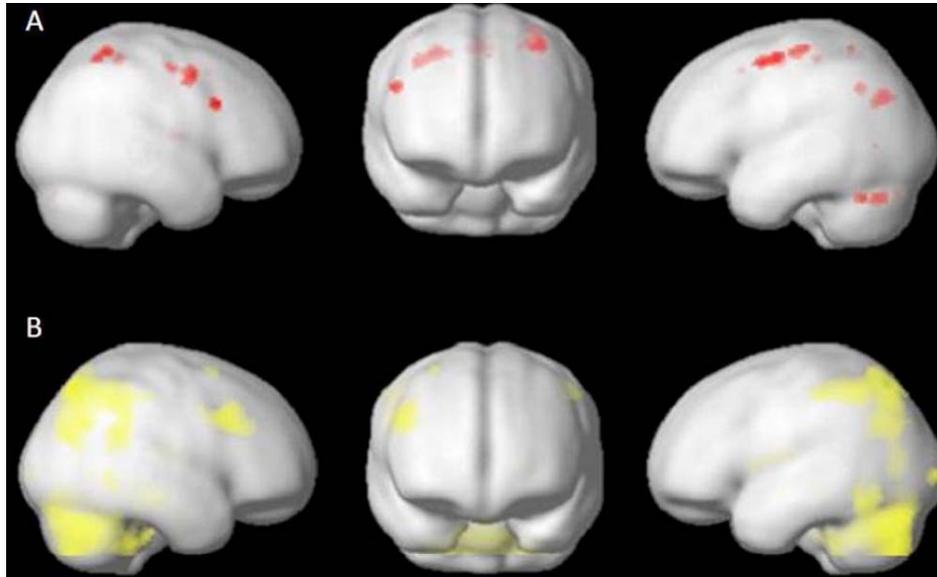


Fig. (2). Representation of the *N-Back* paradigm. **A** and **B** represent the kind of stimuli applied. **(A)** Letters in blue represent the neutral stimuli included in the *0-Back* series which the participant indicated with the movement of his index finger by the IFIS system (In Vivo Inc. Orlando FL) every time a letter was projected in the screen. **(B)** Letters in yellow represent the working memory condition in series *2-Back* in which the participant indicated with the movement of the right index finger when the letter was projected two previous trials and with the left index finger when the letter was not projected in two previous trials. **(C)** Four blocks were presented in and alternated manner in each condition, with duration of 75 second per block. Each letter was projected during 500 ms followed by a fixation cross during 2500 ms.

Table 1. Brain Activations Identified at $p \leq 0.05$ with Family Wise Error Correction while Executing the *Counting Stroop Task* to Assess Attention and Inhibition and the *N-Back Paradigm* to Assess Working Memory

Brain Region	Laterality	Brodmann Area	Z Value	MNI Coordinates		
				x	y	z
<i>Attention/Inhibition</i>						
Middle Frontal Gyrus	L	46	4.5	-52	28	26
Inferior Frontal gyrus	D	9	3.7	60	18	26
Middle Frontal Gyrus	L	9	2.82	-32	22	26
Inferior Parietal Lobule	D	40	3.93	44	-46	54
Inferior Parietal Lobule	L	40	3.63	-48	-40	46
Superior Temporal Gyrus	L	22	3.6	-62	-42	12
Cuneus	L	19	2.77	-6	-88	38
<i>Working Memory</i>						
Inferior Frontal gyrus	L	44	5.57	-54	16	8
Inferior Frontal gyrus	L	47	3.99	-36	-28	-4
Superior Parietal Lobule	R	7	5.05	30	-70	54
Middle Temporal Gyrus	R	22	4.18	62	-38	4
Middle Temporal Gyrus	L	21	3.99	-64	-28	-4
Cuneus	L	18	5.13	-26	-80	28

**Fig. (3).** Cortical surface in lateral and frontal views to illustrate the brain activity identified while execution of the *Counting Stroop Task* (A) and the *N-Back paradigm* (B).

while temporal activation suggest intermediate processes linked with long term memory formation (Baddeley, 2003). The whole brain activity identified in police officers coincide with that reported in civilian healthy samples while making working memory processes (Owen, McMillan, Laird, & Bullmore, 2005) and decisions making based on this mnemonic information (Scaif, *et al.*, 2011). So, prolonged stress

and sleep deprivation conditions may affect working memory execution but not the elemental neurocognitive activity related.

Both cognitive paradigms applied represent indirect measures of inhibition processes. Since frontal activity has been related with moral learning and judgments (Anderson, Bechara, Damasio, Tranel, & Damasio, 1999; Greene,

Nystrom, Engell, Darley, & Cohen, 2004) and neural inhibition of aggressive behaviors (Nelson & Trainor, 2007), the activity in this brain region could represent the inhibitory pathways of impulsivity through the legal and moral codes acquired during the police training and practice. Examples of these codes are represented in the officer's ethnographic results by the officers when mention the helping behavior and social responsibilities as part of their basic traits. The inhibitory system shown by this police sample is correlated with the medium scores manifested in the Plutchik Impulsivity test in the larger sample. In addition, although differences in impulsivity have been attributable to sex variables (Bradley, Codispoti, Sabatinelli, & Lang, 2001; Cross, *et al.*, 2011) the lack of gender differences measured here suggest that the police training and practice may result in an equivalent behavior in women and men.

CONCLUSIONS

Neuroimaging has constituted a technique to identify neural substrates presented during basic cognitive processes. Police population usually relation with presents sleep deprivation due to rotary schedule, this deprivation is classically related with alterations in prefrontal activity, nevertheless brain activation identified in our police sample reflects a normal functional cognitive system. Maintenance of prefrontal activity even in sleep deprived and stressed conditions could imply the participation of this frontal region in several processes required for policing functions, such as a constant alerting system implicating the own and other's safety, suggesting these exacerbated attentional tasks result in a protected brain frontal function.

Aggressive situations manifested by policemen may not be related with impulsive factors but with the perception of injustice in the hierarchal organization of the institution. Even though this work reports an exploratory observation, the integrative method applied could represent an alternative to evaluate the neurocognitive function involving aggression in public servants and the interpretation of this process through the own participants' perception of reality obtained by the ethnological assessment. Therefore, interventional programs to reduce unwanted behaviors may be designed in a more accurate manner when supported by better neurocognitive and ethnological testing.

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CONFLICT OF INTEREST

None.

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