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Orbitofrontal cortex and aggressive behavior in children ages 11 to 13

Corteza orbitofrontal y conducta agresiva en niños de 11 a 13 años

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Abstract:

One of the main points for successful child development is to achieve maturation of the Nervous System. However, growth can be affected by external factors linked to the family or school environment, which can cause behavioral, physical and socio-emotional disturbances to the development of the child, where social skills play a crucial role in preventing aggressive or violent behavior. The objective of this study was to determine the association between the orbitofrontal cortex and aggressive behavior in children from 11 to 13 years old, located in the city of Pachuca, Hidalgo and and neighboring municipalities. With a non-experimental design and a correlational scope, an intentional non-probability. A sample of 118 children participated. The participants were evaluated in two sessions, in the first with the Scale of Assertive Behavior for Children (CABS) and the second the Neuropsychological Battery of Executive Functions and Frontal Lobes (BANFE-2). A low and negative statistically significant correlation was found between aggressiveness and severe alteration in the orbitomedial cortex (r = -.273; p = <. 01). They were also highlighting the relationship between aggressiveness and severe alteration in the orbitomedial zone in males (r = -.302; p = <. 05).In conclusion, children who have a severe dysfunction in the orbitomedial cortex usually are more aggressive than those with an average or high score in this zone.

Keywords:

Orbitofrontal cortex, aggressive behavior, prefrontal cortex, children and executive functions

Resumen:

Uno de los puntos principales para el desarrollo exitoso del niño es lograr la maduración del sistema nervioso. Sin embargo, el crecimiento puede verse afectado por factores externos relacionados con el entorno familiar o escolar, que pueden causar trastornos conductuales, físicos y socioemocionales en el desarrollo del niño, donde las habilidades sociales desempeñan un papel crucial en la prevención de comportamientos agresivos o violentos. El objetivo de este estudio fue determinar la asociación entre la corteza orbitofrontal y el comportamiento agresivo en niños de 11 a 13 años, ubicados en la ciudad de Pachuca, Hidalgo. Con un diseño no experimental y un alcance correlacional. Participó una muestra intencional no probabilística de 118 niños. Los participantes fueron evaluados en dos sesiones, la primera con la Escala de Comportamiento Asertivo para Niños (CABS) y la segunda con la Batería Neuropsicológica de Funciones Ejecutivas y Lóbulos Frontales (BANFE-2). Se encontró una correlación estadísticamente significativa, baja y negativa entre la agresividad y la alteración severa en la corteza orbitomedial (r= -.273; p= <. 01). También destacaron la relación entre la agresividad y la alteración severa en la zona orbitomedial en los hombres (r= -.302; p= <. 05). En conclusión, los niños que tienen una disfunción severa en la corteza orbitomedial generalmente son más agresivos que aquellos con un puntaje promedio o alto en esta zona.

***Palabras Clave**:*

Corteza orbitofrontal, comportamiento agresivo, corteza prefrontal, niños y funciones ejecutivas

INTRODUCTION

Among the disruptive, impulse control, and behavioral disorders are behavioral disorders (CT), which in childhood are reported in the psychological care services as the most frequent mental health problem at this stage of development and even during adolescence (Hewitt & Rey, 2018). Due to the aggressive and problematic characteristics of the behavior, many children are rejected by their environment, which causes social maladjustment in family and school contexts (Morales, Martínez, Nieto, & Lira, 2017; Gutman, Joshi, Khan, & Schoon, 2018). Children who have limited prosocial emotions are more likely to show aggressive behaviors and deficits in social skills (Hewitt & Rey, 2018).

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Aggressive behaviors are characterized by attitudes towards another person to cause harm, whether physically, verbally, or relationally. The first one that can be most easily distinguished since it is observed with behaviors such as hitting, punching, kicks, among others. Aggressive verbal behaviors are more aimed at the use of nicknames, insults, or threats. Finally, the relational one that is carried out when it prevents social development with their group can be observed in aggressive behaviors such as social exclusion (Torregrosa et al., 2010; Rodríguez-Machain, Berenzon-Gorn, Juárez-García, & Valadez-Figueroa, 2016).

The risk factors reported in the literature show a complex and multicausal etiology, with the presence of factors that predispose a child to present aggressive behavior, beginning with the role of the family and social system in which it develops. Parenting within the family can influence the development of an aggressive child (Fajardo-Vargas & Hernández-Guzmán, 2008).

The etiology related to biological factors indicates the presence of genetic factors and the presence of factors that function as environmental stressors that can affect neurodevelopment. Neurochemical factors as low serotonin, low physiological reactivity to emotions, and deficits in hot executive functions (emotional regulation and decision making) and also in cold ones (such as working memory, cognitive flexibility, and verbal fluency), as well as errors in the processing of social information and a low IQ, are related to the etiology of aggressive behavior in children (Frick, 2016; Hewitt & Rey, 2018; Rubia, 2011).

Other studies show that if an infant is exposed to violent environments, undergoes a modification in the cortical network and shows fewer connections with other regions, compared to young adults who have not been mistreated, this area is essential because it participates in the regulation of emotions and impulses (Teicher, Anderson, Ohashi, & Polcari, 2014).

Even though behavior problems, specifically those that present violent or aggressive behaviors, have a multicausal origin (social, family, drug use, among others), it is crucial to evaluate the possibility that they are the product of a neurological problem. Since a malformation, neurodevelopmental alterations, accidents, or even extremely stressful events (Jara & Ferrer, 2005), could facilitate its appearance. For example, damage to the Prefrontal Cortex (PFC) area can trigger problems such as hyperactivity, lack of empathy, aggressive behaviors, emotional and social withdrawal (Rolls, 1996).

Likewise, the PFC of the human being has developed remarkably in comparison with other species, inferring importantly in the movement and especially the behavior, that is why due to its role in so many superior functions, the PFC in the human being It has been referred to as 'the organ of civilization' (See figure 1) (Churchland, 2011).

A small part of the prefrontal cortex is the Orbitofrontal Cortex (COF), which is located at the base of the frontal lobes, at a point higher than the eye sockets, this area is involved with social tasks, in addition to being the last region to myelinate and develop, since its development continues until approximately 30 years of age (Lozano & Ostrosky, 2011; Luria, 1986) (see figure 2).

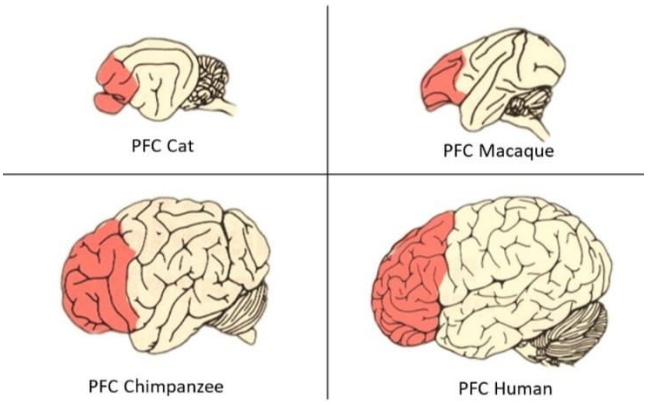

Figure 1. Comparison of the size of the Prefrontal Cortex in four different species. Adapted from: "Skills for a social life" by P. Churchland, 2011, What Neuroscience Tells Us about Morality.

The primary function of the COF is emotional regulation and control, as well as behavior control. Besides, to allow the detection of beneficial or harmful conditions for the subject concerning the situation or the environment in which they find themselves, which will modify their behavior (Rolls, 2000).

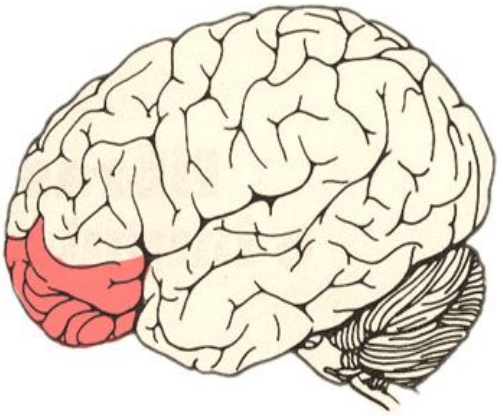

Figure 2. Orbitofrontal Cortex Location
Own elaboration.

That is why various studies mention that behavior can be affected by damage in a specific area of the brain; therefore, damage to COF is linked to impulse control, learning from past mistakes in behavior and focusing on attention (Scicutella, 2007; Semrud-Clikeman & Teeter, 2009).

Equally important, children with behavior problems tend to have lower than average IQs, specifically a low verbal IQ, language deficit may be the main characteristic for presenting difficulties in understanding the consequences of behavior and the inability to monitor and control behavior in an accurately way (Pennington, 2002).

One of the most relevant conditions mentioned in the literature in these cases is the orbitofrontal syndrome since it includes the presence of different neuropsychiatric symptoms that modify behavior, cognition and affect, depending on the injury in the OFC, which makes it impossible for the person to be able to distinguish what occurs in the perception of external behaviors, for example, to inhibit possible aggression (Muñoz, 2017). Due to the importance of this region, the objective of this research was to identify the relationship between the orbitofrontal cortex and the deficit in social skills, particularly in the presence of aggressive behaviors in children between 11 and 13 years old.

METHOD

This research is a descriptive study of correlational scope, where the sample was formed in an intentional non-probabilistic way by type subjects (González, Escoto & Chávez, 2017). One hundred eighteen (n=118) children from 11 to 13 years old with an SD = .773 participated. The inclusion criteria were: 1) to be students who had the informed consent signed by the mother, father or guardian, 2) assent of the minors, and 3) to answer all the assessment instruments. In this study, two instruments were used: the first, the Scale of Assertive Behavior for Children (CABS) by Michelson, and Wood (1982) adapted for the Mexican population by Lara and Silva (2002), it has an internal consistency of α = .80. Allows identifying the communication style of boys and girls. The higher the score reflects the more aggressive style, the average score a passive style, and the lower score an assertive style. It has 27 items, each with five response options.

The second instrument used was the Neuropsychological Battery of Executive Functions and Frontal Lobes (BANFE-2), an instrument that groups a significant number of highly reliable and valid neuropsychological tests for the evaluation of cognitive processes that mainly depend on the prefrontal cortex. This instrument seeks to evaluate 15 processes related to Executive Functions, which are grouped into three specific areas: Orbitomedial, Anterior Prefrontal, and Dorsolateral. The BANFE-2 represents a comprehensive and simultaneously accurate neuropsychological assessment proposal that is suitable for both children and adults. It also allows determining which areas within the various regions of the CPF are compromised by damage or dysfunction in a relatively short time of application (Flores, Ostrosky & Lozano, 2014).

Procedure

Prior to the evaluation, contact was made with the public school of the State of Hidalgo, through the teaching and management staff. Authorization and signature of the informed consent from parents or guardians were requested, as well as minors' assent. The CABS group application was carried out digitally, with qualified evaluators to supervise the application and resolve questions from the participants. Regarding BANFE-2, the application was with each of the participants, by psychologists previously trained in the use of this battery. Instruments were graded and captured in SPSS version 25 for further analysis.

RESULTS

The 46.6% (n = 55) of the participants were boys and 53.4% (n = 66) girls, aged 11 to 13, who at the time of the study were residents of the state of Hidalgo, all from urban municipalities.

The Assertive Behavior Scale for Children (CABS) was used to assess social skills, in which the participants obtained an *X*=50.97 and an *SD*=11,514, finding an aggressive style above what was expected (See Table 1). This style is characterized by the existence of fights, accusations, threats, and other aggressive behaviors among infants. Boys obtained an *X*=53.84 (*SD*=12,953), which is higher than that of girls who obtained an *X*=48.46 (*SD*=9,505), this indicates that boys behave more aggressively while girls tend to do so passively.

Table 1
Averages obtained by sex in the CABS questionnaire.

Boys		Girls		Total	
X	***SD***	***X***	***SD***	***X***	***SD***
53.84	12.953	48.46	9.505	**50.97**	11.514

The percentages observed in each communication style show that the boys and girls in this study have a deficit in social skills since it was found that 42.37% (n = 50) use the aggressive style to communicate. In comparison, passive communication was present in 33.89% (n = 40), and finally, the type of communication that presented the least percentage was assertive with 23.72% (n = 28) (Table 2).

Table 2
Communication style identified with CABS, in all study participants.

	Assertive	Passive	Aggressive
Percentage	23.72%	**33.89%**	**42.37%**

When performing a descriptive analysis of the communication style between boys and girls, it was found that 47.27% of boys and 38.09% of girls present a more aggressive style, followed by a passive style with 32.72% in boys and 34.92 % in girls, being in both cases the assertive style the one that appears less frequently, as can be seen in Table 3.

Table 3
Comparison of the percentages of use of each communication style by sex identified with the CABS.

Sex	Assertive	Passive	Aggressive
Boy	20%	32.72%	47.27%

Girl	**26.89%**	**34.92%**	**38.09%**

To evaluate the orbitofrontal zone, the Neuropsychological Battery of Executive Functions and Frontal Lobes (BANFE-2) was used. The evaluated children present an *X*=89.62 and an *SD*=23.281 that indicates they are within the normal parameters according to their age. Despite the fact that both sexes are within the normal range, boys have an *X*=85.45 and an *SD*=22,197, which is slightly lower than that of girls who have an *X*=93.25 with an *SD*=23,768, as can be seen in Table 4.

Table 4
Averages obtained by sex in the neuropsychological battery of executive functions, orbitomedial zone.

	Boys		**Girls**		**Total**	
	X	***SD***	***X***	***SD***	***X***	***SD***
OM Zone	85.45	22.19	**93.25**	23.768	89.62	23.28

OM Zone = Orbitomedial Zone

In the analysis of data from the orbitomedial zone, shown in Table 5, it was found that the majority of the population, that is, 55.08% is in a normal range; likewise only 11.86% was recorded with alteration moderate and 20.33% of the participants with severe alteration in this area. When adding the percentages between moderate and severe alteration, it is observed that 32.19% have some alteration while only 12.71% present a high normal performance.

Table 5
Percentage corresponding to the Orbitomedial Subtotal by the level of alteration.

	SA	**MMA**	**N**	**HN**
Percentage	**20.33%**	**11.86%**	55.08 %	12.71 %

Note: SA=Severe Alteration/ MMA=Mild-Moderate Alteration/ N=Normal/ HN= High Normal

As can be seen in Table 6, boys are those who present a higher percentage of severe alteration in the orbitomedial zone compared to girls, having percentages of 27.27% and 14.28% respectively, on the other hand, girls are those who obtained a higher percentage in the high normal score with 20.63%, while the boys had only 3.63%.

Table 6
Comparison of Orbitomedial Subtotal by sex.

Sex	**SA**	**MMA**	**N**	**HN**
Boys	**27.27%**	7.27%	61.81%	**3.63%**
Girl	**14.28%**	15.87%	49.20%	**20.63%**

Note: SA=Severe Alteration/ MMA=Mild-Moderate Alteration/ N=Normal/ HN= High Normal

Regarding communication styles, most of the children with severe alteration in the orbitomedial area presented an aggressive common style (see Table 7).

Table 7
Cross table showing the frequency between communication style and diagnosis in the orbitomedial area.

Communication style	**SA**	**MMA**	**N**	**HN**
Assertive	1.69%	3.38%	13.55 %	5.08%
Passive	4.23%	3.38%	23.72 %	2.54%
Aggressive	**14.40 %**	5.08%	17.79 %	5.08%

Note: SA=Severe Alteration/ MMA=Mild-Moderate Alteration/ N=Normal/ HN= High Normal

Regarding the correlations, the CABS test had a statistically significant low correlation with the BANFE-2 orbitomedial area (r=-.273, p=<.01). That indicates that the more aggressive communication (higher CABS score), the less development will be in the orbitomedial area of BANFE-2 (identifying more significant alteration).
On the other hand, only with a male population was a statistically significant correlation found between CABS and the orbitomedial area (r = -.302, p= < .05).

DISCUSSION

As it has been observed, the behavioral problems that begin in childhood characterized by frequent hostile actions, constant discussions, disobedience, produce a deterioration in the development of social skills within various areas of interaction, such as school, family or social environment (De la Peña-Olvera & Palacios-Cruz, 2011).
That is consistent with a study developed by Harris (2003), where he mentions that some problems in social skills such as aggressiveness and behavior control in an environment can be affected, not by one, but by various factors, such as an unfavorable environment, personality or temperament of the person, the upbringing and the danger or integrity of our brain. That is why neurosciences allow us to understand a variety of phenomena related to the expression and recognition of emotions and behaviors, which helps us better understand any deficit that is reducing child development (Fernández, Dufey, & Mourgues, 2007).

Some studies relate the prefrontal cortex and the limbic system, where PFC's inhibitory control influences the amygdala. That means that if a person does not have good control of their impulses, they will have high activity in the amygdala area, and little activity in the PFC, however, if a person controls his impulsive attitude, he will have high activity in the PFC. If a person has an injury in the PFC, it would mean an increase in impulsive and violent behaviors (Ortega & Alcazar, 2016).

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Neuropsychology contributes to the evaluation of the Prefrontal Cortex, facilitating its incursion in understanding the origin and development of behavioral problems through specialized tests that measure the condition in these areas (Bausela, 2014).

CONCLUSIONS

Derived from data obtained in the scores of the orbitomedial zone and according to what is stated in the literature, it can be inferred that the inhibitory control and the detection of risk behaviors at this age are average, but it is still in the process of maturing.

The data obtained in this study confirm that boys tend to have more aggressive attitudes compared to girls, and it is consistent with the literature, according to a study by Reyna and Brussino (2015).

It is essential to know how to distinguish when there is violent behavior due to some alteration in the orbitofrontal cortex since a problem of neurological origin is not the same as one caused by social learning (Arango, Romero, Hewitt, & Rodríguez, 2018).

Children who have a problem in the prefrontal cortex are usually very irritable, with emotional lability and little touch, in addition to being unable to understand social cues, responding only to present stimuli (Lacunza, 2012; Ardila & Ostrosky, 2008). Hence the significant impact that social skills have in the course of childhood, into adulthood, since they directly affect our self-esteem, academic performance, the roles we exercise, and especially the regulation of our behavior (Lacunza, 2010).

It is crucial to carry out an excellent psychological evaluation since it will allow us to make timely decisions to intervene, prevent risky behaviors, and improve the child's development and quality of life (Contini, 1999).

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