

## Executive Functions and Levels of Stress in Decision-Making: A Study of Adolescents with Cleft Lip and Palate

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### Abstract

**Aim and objective:** The objective of the study was to evaluate the executive performance in the decision making process of adolescents with cleft lip and palate and their relationship with stress and cortisol levels.

**Method:** The data were obtained through the neuropsychological evaluation instruments of the Wisconsin Card Test, the Raven Progressive Matrix Test (General Scale), the Iowa Gambling Task, and the Elisa test, through the collection of saliva, to evaluate the levels Of cortisol in 50 male adolescents with cleft lip and palate, HRAC / USP patients (group 1) and another 46 without the fissure (control) male (Group 2), all aged 14 to 17 years. The analysis of the research data was performed using different non-parametric tests: Mann-Whitney Rank Sum Test; Chi-square, Spearman Rank Order Correlation; Kruskal-Wallis One Way Analysis of Variance on Ranks.

**Results:** The results of the present study pointed to the executive functions preserved in the young people who composed the sample and suggest that the lack of engagement in the activities may be due to ineffective educational practices, rather than limitations in the cognitive resources of executive functions.

**Keywords:** Executive function; Cleft lip palate; Decision making; Stress; Neuropsychology

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### Introduction

Neuropsychological research in the area of craniofacial anomalies has intensified the investigation of the superior cortical functions among this population. The cognitive abilities of a contingent of individuals with CLP, without syndromic involvement, are within the expected range for age and schooling, however, another part of this population shows impairments in memory, language and executive functions [1-5]. Richman and Nopoulos [6] identified in their study with this population, language problems and associated factors, as well as difficulties in naming skills.

A meta-analysis [7] examined the psychosocial and cross-cultural impact of fissure. The findings indicated that men with CLP in cultures of non-English origin are more prone to psychosocial problems than women, but adults are also more affected than adolescents. The results showed that individuals with CLP presented lower psychosocial development than individuals without CLP, regardless of age, gender or culture. In a

neuroimaging study [8] measured the brain size of adult men with CLP and compared them with those of adult men without CLP. No differences were found in overall brain size, however, some differences were noted: a significant reduction in the volume of gray matter in the cerebellum; frontal and parietal enlargement and reduction of occipital temporal lobes of individuals with CLP in relation to the control group. It was speculated that such findings could be related to the neuropsychological performances of individuals with CLP, which may contribute to the understanding of low cognitive performance.

Psychosocial factors related to the anomalous appearance of the face can cause negative impacts on the quality of social interactions and self-esteem. CLP has been associated with increased social inhibition or shyness [9]. The researchers conducted a study to evaluate whether psychosocial factors related to the appearance

of the face would lead to a low self-concept. The study included 30 boys, aged 7-12 years old, with CLP and one control group (without CLP) in the same age group. Participants were assessed in terms of social function and self-concept through standardized questionnaires that were completed by them and one of their parents. The volume and surface area of the frontal ventromedial cortex (FVC), composed of the frontal orbito cortex (COF) and straight gyrus (GR), were evaluated using magnetic resonance imaging (MRI). The results showed that the social function of the group with cleft was significantly impaired compared to the control group. There were no differences between groups regarding self-concept. Significant differences were found in the morphology of the ventromedial cortex. In particular, the volume and surface area were decreased in the left straight gyrus (GR) of the cleft group.

Frontal regions of the brain play a critical role in complex and organized human behaviors such as social interaction, executive functions and decision making. It has been extensively documented [10,11] for the actions of the prefrontal cortex and its subcortical connections, emotion modulation and planned actions, whose emotional responses to environmental stimulus, behavioral responses that influence interaction and decision making. The relation of the social role in this cerebral circuit can be explained, in part, by the anatomy of the orbital and medial cortex. The ventral surface receives multimodal sensory information from subcortical nuclei responsible for the emotions integrating visceral, sensorial and affective signals [12]. The locations of these structures set informational flow paths through which sensory input can influence affective and cognitive processes by directing and interfering with complex behavioral actions.

These findings point to the importance of neuropsychological assessments and interventions as part of the rehabilitation process administered by CLP health teams. Affective and social compromises, coupled with specific cognitive impairments, can configure potential risk conditions for brain processing in complex actions that require the integrated functioning of different domains, such as the operationalization of executive functions.

Behaviors that allow the individual an intentional and planned interaction involve the elaboration of an action strategy based on previous experiences, as well as stimuli or demands, present in the environment. Such activities need to be flexible, adaptive and monitored at each stage of implementation. These operations are called executive functions [13]. Executive functions relate to the control and regulation of information processing in the brain. Executive functions consist of a set of cognitive conditions necessary to manage contingencies and demands in function of a goal.

The production and management of executive processes have been identified as a central function of the prefrontal cortex (CPF) through the retrieval and archiving of memory information based on sensory information. Behaviors that allow the individual an intentional, planned interaction, involve the elaboration of an action strategy, based on previous experiences, as well as on stimuli or demands present in the environment. Behaviors

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## Purpose

The present study aimed to answer the following questions: Do subjects with cleft lip and palate present adaptive and functional levels in terms of executive function and decision making? Are there any significant differences in the executive performance of decision making of adolescents with CLP compared to a control group? Do different cortisol levels influence performance in decision making? If so, are there significant differences between individuals with CLP and the comparative group? The present research had an exploratory character with the potential to subsidize the understanding of behavioral data related to the psychological risk and to the protection of adolescents with CLP.

## Materials and Methods

The project was submitted to the Research Ethics Committee of HRAC / USP, approved by the opinion of n. 885800 of 11/17/2014. A total amount of 96 male adolescents, aged 14 to 17 years old, participated in the study comprising two groups: GI, formed by 50 participants with repaired CLP. GII, with 46 adolescents without CLP. The inclusion criteria for participation in the GI study was to have a diagnosis of cleft lip and palate, enrolled in the HRAC / USP, to be in the age range of the study, and the authorization of parents or guardians. To formally consent to spontaneous participation in research. The inclusion criteria for the GII consisted in formally consenting to the participation of the research, presenting age at the proposed age range, to be regularly enrolled at schools of the official public school network and having parental consent. Exclusion criteria for both groups were those of having a syndromic diagnosis, sensory or neuropsychiatric deficiency. Present interfering systemic disease in the immune system. Make use of neurological and / or psychiatric medications. The entire sample of participants is composed of children and adolescents belonging to families of low socioeconomic level who use public health services such as HRAC / USP and Mirim Foundation of Araçatuba.

The instruments used to collect data from the survey were Raven's Progressive Matrices [15], Winsconsin Sording Card Classification Test - WSCCT [16], Iowa Gambling Test - IGT [17] and Measurement of Cortisol Levels by ELISA Test (for Saliva, Enzyme Linked Immunosorbent Assay) (Tables 1 and 2).

The analysis of the research data was performed using a normality test, verifying the non-distribution normal of the data. For this

**Table 1** Ravens's Progressive Matrices Test – General Scale.

Groups	G1		G2		p-value
Categories	s	%	S	%	p=0.003*
Discrepant	0	0.0	10	21.7	
Evidence of Disability	9	18.0	12	26.1	
Lower than average	19	38.0	12	26.1	
Average	20	40.0	12	26.1	
Above Average	2	4.0	0	0.0	

**Table 2** Percentage representation of the Elisa test regarding the mean, median and standard deviation.

Cortisol Ng/ml	n	Median	25%	75%	Average	SD	p-value
G1	50	7.6	6.8	10.1	9.7	7.5	p=0.773
G2	46	7.2	6.9	9.4	9.8	6.2	

reason the use of a non-parametric approach was used in the data analysis by Mann-Whitney Rank Sum Test; Chi-square, Spearman Rank Order Correlation; Kruskal-Wallis One Way Analysis of Variance on Ranks.

## Results and Discussion

The results obtained in the present study were described and analyzed in order to understand the cognitive resources of young people with cleft lip and palate. The literature has described that the condition of the facial anomaly of this population has influence on the academic, social and emotional development, independently of the identified intellectual levels [18].

Cognitive-language deficits, reading and writing difficulties and operational memory in studies of individuals with FLP have been documented [19-21]. However, the results of the present study differ from previous studies regarding the verification of differences in cognitive performance and neuropsychological functioning of individuals with cleft lip and palate since no differences were observed between groups, thus demonstrating that adolescents with cleft lip and palate presented executive performance similar to the adolescents in the control group. Despite this, some observations are important for understanding and discussion.

In the comparison of the groups, there was no difference in performance regarding the age of the participants that ranged from 14 to 17 years with a mean age of 16 years. However, it is important to emphasize that the present study had the reference of a group considered social vulnerability, where behavioral and psychosocial factors may have interfered in the performance of tasks. Even though they did not have a statistical difference, the performances were lower in both groups regarding the aspects related to attention support, motivation and operational memory. The existing literature on increased risk factors and minimized protective factors, interfering with the cognitive and psychosocial development of children and adolescents, is indicative of relevant conditions in a clinical diagnostic evaluation of low academic performance [22,23].

In the comparison of the groups on the intellectual level, there was a statistically significant difference ( $p = 0.003$ ) where G2 showed a marked "discrepant" behavior in the Raven Progressive

Matrix test. When checking the consistency of the results, it was observed that 21% of the reference group (G2) sample were of non-consistent cases, that is, they reached discrepancies greater than + or - 2. The discrepancies in the standardized test results are understood in the reliability of the response, and may be associated with having been given to chance by the examiner [15].

Given this scenario it is possible to infer that a cognitive bias and motivational factors may have interfered in the performance of the participants during the administration of the test. Because they are not in a health care context, such as in the hospital setting, where invitations to spontaneous participation in research and evaluation procedures in the treatment process are frequent, G2 members may not have assigned the same importance as the G1.

In a comparative study [24] evaluated the language, perception, memory and executive functions of young people with and without FLP. The results showed significant differences in the FLP group, which showed a deficit in language functions and verbal memory, but did not present differences in terms of executive function. In the present study there was also no difference between the groups when compared in the performance of executive functions. Executive functioning refers to the joint and integrated action of the various cognitive domains that allows the elaboration of planned and goal-directed actions [25].

Some authors classify the executive functions in "hot" and "cold" [26] a distinction between the development of affective aspects called "hot" that are associated with the orbitofrontal cortex (OFC) and the development of more cognitive aspects associated with the dorsolateral prefrontal cortex [27] called "cold". Decision making configures the executive stage in which it is necessary to reconcile the conflict between available choices in the context of a set of rules, as well as to control the impulses of immediate reward in favor of a choice that may be more assertive, despite a future reward occur later. The results of this study allowed us to understand that, although comparatively the groups did not have statistically significant differences, a contingent of both showed impairments in the executive abilities of cognitive flexibility and decision making.

First, the WSCT was applied. Despite the errors that the evaluator may make in the discrimination of the combination criteria and

the possible discomfort resulting from this, compared to the IGT, the WSCT can be considered a more "cold" characteristic evaluation. The IGT, in turn, besides the discomfort of the bad choice, presents concrete consequences such as loss or monetary gain, which accentuates the affective influence of future choices. Comparison of salivary cortisol levels, collected after administration of WSCT and prior to IGT, revealed a similar mean (9.7 Ng / mL G1 and 9.8 Ng / mL G2), with no statistically significant difference ( $p = 0.773$ ), indicating homogeneity in cortisol levels between groups, and therefore, equivalent stressor pattern, in normality parameters.

Considering G1, the target group of this study, it is known that the rehabilitation process of the cleft lip and palate is independent, regardless of the type involved, being closely associated with the complexity of the cleft, which may occur alone or in association with the lip, alveolar ridge, palate primary and secondary, and may be associated with other genetic and clinical syndromes, although it is not pertinent to the present sample [28,29].

It is understood that the restorative surgeries promote great expectation, both of the individual, as well as of the family and the social circle in which it is inserted. However, the rehabilitation process is not restricted to the anatomical repair of the fissure, since it affects functions such as speech, hearing, occlusion development and craniofacial growth, as well as interfere in the psychological, academic and social development [30]. However, the present study demonstrates that the coping capacity of young people with FLP, who made up the sample, did not prove to represent stressful conditions in contingency decision making.

From the perspective of coping strategies, Cognitive Psychology characterizes coping as a series of tactics used by the individual in an attempt to adapt to a specific stressful demand. Coping can be focused on emotion when it is designed to alter the emotional state to reduce unpleasant physical sensations from the stress state. Coping can also be focused on the problem, when it aims to change the existing situation in the relationship between the individual and the environment. Both types have the function of managing stressful contingencies [31].

Stress can be overwhelming in people with greater vulnerability, due to lived experiences, personality characteristics, received training education, among other risk factors and protection. In a vertiginously opposing condition, it can be considered that young people with risk factors for developmental changes experience atypical situations that can strengthen the coping ability and resolution of practical and affective problems, characterizing coping [5]. In this way, it is understandable that adolescents with cleft lip and palate use coping, the intrinsic efforts to deal daily with chronic, acute or debilitating situations and, therefore, able to develop compensatory strategies in an attempt to adapt to a specific stressful demand [29]. Adolescence begins at puberty, at which stage morphological and psychological changes occur that approach adulthood. According to the World Health Organization, adolescents between 10 and 19 years of age are considered adolescents. Adolescence is a period in which attitudes, values and behaviors are established in relation to behavior, which begin in childhood, coming from the family. Frequently, clinical

complaints in the hospital routine of young people with CLP in the participating rehabilitation hospital indicate the difficulty of incorporating targeted habits in the treatments, whose behaviors reflect the lack of adherence to the changes for adaptation in the daily routine. Thus, the results of the present study, which pointed to the executive functions preserved in a percentage of young people who composed the sample, suggest that the lack of engagement in the activities may be due to ineffective educational practices, rather than limitations in cognitive resources of executive functions [32].

Adolescence is a phase of changes and questioning of the values acquired in childhood, where, assuming responsibility for oneself or another, implies psychological maturation, preparing the being for adulthood. Often this scares the young man and can lead him to remain in a zone of comfort of dependence, where the family can reinforce (without conscious intention) the behaviors, infantilizing them.

In the present study, a percentage of G1 had a lower level of logical reasoning, implying cognitive limitations in terms of generalization of information and deductive understanding of subjective situations. This aspect could be considered a contributing factor to the difficulties in incorporating rules and independence in the activities of daily living. However, considering the cognitive performance related to flexibility to identify and solve problems (according to the WSCT and IGT), dependent and immature behaviors suggest to be due to overprotective contexts, limited in understanding the impact of the effects on the formation of adolescents, such as fragility in the engagement to chronic treatments. In this respect, they know what they should do, but expect to be led.

The present study allowed us to conclude that the performance of the groups, in terms of executive function, cognitive flexibility and stress levels did not present significant differences in statistical analysis, although functions and competencies related to failure to maintain the context, cognitive functions involved in sustaining attention, motivation and use of operational memory, were lagged in relation to the expected pattern for the age group, with 24% in G1 and 36.2% in G2.

## Conclusion

The vulnerability condition of both groups, either by atypical conditions of development (G1) or economic-social risk (G2), represented patterns of similarities in the skills tested, which, although with important lags in performance, can be justified by the statistically significant differences. The difficulty of incorporating procedures and habits of fundamental importance for the process of rehabilitation of young people with FLP is a frequent complaint of professionals who work in the process of rehabilitation of rehabilitation in the hospital routine. Such lack of engagement and treatment-oriented care often reflect a lack of adherence to changes in the adaptation of the rehabilitation process to the daily routine. Thus, the results of the present study, which pointed to the executive functions preserved in a percentage of young people who composed the sample, suggest that the lack of engagement in the activities may be



due to ineffective educational practices, rather than limitations in cognitive resources of executive functions. The study pointed to some limitations, one of them referring to the collection of saliva for analysis of cortisol levels. The fact that the collection done with the adolescents occurred at different times, which may have been an influencing bias in the levels of concentration in the participants' body, given the great variation of their production throughout the day. The fact that the collection was not performed in two moments of comparison, before and after the administration of the cognitive assessments, can be considered a limiting factor, since it would refine the information on the hormonal behavior of the participants.

The non-division of the group of adolescents with FLP in different

types of fissures represented another bias, as it would provide information pertinent to differences in executive decision-making skills. Considering the fact that both groups represent adolescents from populations at risk and social vulnerability, not using a third group of adolescents, whose representatives were not at risk, could provide information typical of the cognitive development of adolescents, through comparative analysis.

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