

Conference Paper

Effects of Neuropsychological Intervention in a Child with Functional Deficit in Programming and Control

Maria Fernanda Ochoa Cardona and Luis Quintanar Rojas

Autonomous University of Puebla (MEXICO, Puebla)

Abstract

Introduction. The brain's third functional block is considered an important element in the impairment of child development, which has been conceptually linked to ADHD and learning difficulties. Its rehabilitation presents some skepticism regarding the effectiveness of the treatments. This is associated with the lack of relationship between the established diagnosis and the intervention proposal, the lack of knowledge of the basic psychological needs of each age and the design of an intervention program that corresponds to the neuropsychological syndrome.

Methodology. The main purpose of this paper is to present the results of a neuropsychological intervention in a 11-year-old schoolgirl from the city of Puebla-México with a functional deficit in programming and control mechanism. The intervention program was scheduled twice a week for 11 months; gauging its effectiveness with pre-post neuropsychological and electroencephalography (EEG) assessment. The EEG data revealed functional bilateral changes of origin in basal ganglia, mesencephalic and of the brainstem. The method of qualitative syndromic analysis of the functional status of the cerebral mechanisms was used, especially in mistakes made at different tasks associated with the mechanism involved. The program was elaborated based on the structure and content of the school learning activity and zone of proximal development.

Results. A significant improvement was observed in the functional state of programming and control and improvement in school performance.

Conclusion. Approaches to child correction like the cultural-historical are necessary in the neuropsychological field to generate methods that guarantee the psychological and neuropsychological development.

Keywords: Neuropsychological syndrome, child neuropsychology, child neuropsychological intervention, developmental problems, subcortical structures.

Corresponding Author:

Maria Fernanda Ochoa Cardona
 fernanda.ochoa@alumno
 .buap.mx

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1. Introduction

Nowadays, it is evident that frequency of school failure is increasing in Latin America. There is a social need to count with professional neuropsychologists in order to point out the possibilities of assessment of children with learning disabilities. Neuropsychology is a discipline, which is able to open broader perspectives for the development and learning of children who present these difficulties, establishing precise clinical impression. The notion of clinical neuropsychological syndrome, in the case of each case of learning disabilities might help to establish the aims of intervention and preventive programs to counteract this social reality.

The study of behavioral regulation in childhood has required the convergence of diverse research with different theoretical assumptions about development process [1]. Concepts such as inhibition of behaviour, regulation or self-control have been discussed. All these terms, converge at implying the ability to modify the behavior according to the cognitive, emotional and social demands raised in a specific context [2]. However, these approaches fall short while trying to address a concept as complex as human behavioral regulation, leaving a gap for an in-depth explanation of the organization of its functions, and the neural substrates of this concept.

The historical-cultural approach tries to explain the regulatory process, considering it as the brain mechanism of regulation and control, which can be understood as one of psychophysiological mechanisms of actions and operations. It is a key factor in the organization of the complex conscious voluntary activity and in the creation of intentions, the training, inspection of execution and regulation of each behaviour, which is necessary to carry out plans and programs of actions. Finally, it is an essential mechanism in self-verification of the task, in such a way that the effects of the actions are compared with the original intentions, correcting the errors that have been committed [3].

These tasks are performed by structures corresponding to third functional unit. This is related to anterior regions of both hemispheres, specifically to the prefrontal areas of the frontal lobe. Despite the connection with the frontal lobes (especially the prefrontal portion), it's pointed out that cognitive processes cannot be mapped in stable and fixed brain regions and that neural activation is a dynamic process that moves in space and time [4]. From this point of view, diverse subcortical structures, which take part in regulation of complex serial movements should also be considered as a part of third functional unit.

The process of rehabilitation, correction and development of this brain unit has been proposed through the intervention of the intellectual activity. Such kind of activity is considered the fundamental form of the knowledge of the reality of man, which requires an integration of all different psychic processes [5]. Luria has defined intellectual activity [6] as the problem solving in an organized way, which requires a previous analysis and a synthesis of the situation and necessity of finding certain auxiliary operations to solve this. It appears only when the subject has concrete motive, as a new problem to solve. The step that follows immediately after the discovery of the task, is not a direct attempt to respond but a restriction of impulsive responses and a preliminary analysis of the conditions. Reflective necessity of prior orientation of the task leads to a certain hypothesis that raises the possibility of the emergence of essential and secondary links. Afterwards, this hypothesis establishment provides a selective character to the whole process of problem solution. It is necessary for the subject to know how to choose the specific operations (plan of action) and how to apply them in appropriate sequence. Finally, on the stage of verification of obtained results, reflective comparison with the initial approach of the task and correction of inadequate solutions should be carried out.

According to the previously expressed, the aim of the study was to determine the effects of a neuropsychological intervention with the pupil of primary school with severe functional deficit in regulation and control. The process of elaboration and implementation of the program of correction was based on the principles of historical and cultural neuropsychology [7, 8].

2. Methods

The present research was conducted as a single case study, according to quasi-experimental design. The participant was a girl of nine years old, left handed, a pupil of the fourth grade of primary school. She received previous diagnosis of attention deficit hyperactivity disorder (ADHD) and had a long history of poor school performance without receiving any treatment.

2.1. Procedure

The neuropsychological intervention program was applied during the nine months, in individual 60-minute sessions twice a week with a total amount of 59 sessions. Once the application of the neuropsychological intervention program was completed,

an assessment was conducted with the same neuropsychological instruments applied in the initial evaluation. Electroencephalography analysis was performed before neuropsychological correction. Finally, the data obtained in both pre-post assessments was contrasted.

The main aim of the program was the achievement of organization of the regulation and control of school actions of the girl together with general improvement of voluntary activity. The method of gradual internalization of school actions were implied [8, 9].

Specific objectives of the program were: a) to improve different aspects of writing (respect for capital letters, punctuation marks, spelling), b) to improve reading comprehension, c) to develop the possibility of solving arithmetic problems, d) to plan behaviour of playing tasks with respect of rules and terms of table games.

The program was based on conception of the zone of actual and proximate development [9]. The tasks of the program began in accordance with the zone of actual development (materialized perceptual stage) of the girl and the possibility of achieving it with the help of the neuropsychologist and to pass gradually to the zone of proximate development (perceptive symbolic actions).

The structure of the program was divided into three phases 1) establishment of analysis and verification of strategy in reading and writing tasks; 2) solving of mathematical problems; 3) development of recreational activity (Table 1).

2.2. Instruments

Initial and final neuropsychological assessment was carried out by instruments of qualitative instrument Spanish speaking children [11–13]. In addition, EEG study was carried out.

3. Results

Results of final assessment pointed out the presence of positive effects of the program. These were observed in different types of tasks of neuropsychological assessment and in tasks of school success (reading, writing and arithmetical calculation).

Important changes were observed in tasks for audio-verbal and visual retention, like the stability of the volume of mnesic traces. The Figure 2 shows examples of changes observed in the executions of the girl after neuropsychological correction such as the

TABLE 1: Structure of the intervention program.

Analysis and verification of strategy in reading and writing tasks	Formation of strategies for solving arithmetic problems		Planning of table games with analysis of rules and structure
Analysis of phonological structure of words, analysis and production of sentence levels based on the method for initial training of reading.	Elaboration of drawings or schemes for each operation	Guide card for identification of conditions of each task: 1. Find data and question 2. Answer if problem is logic or not 3. Find arithmetic operations according to key clues (more than, less than, so many times, etc.) 4. Review values, procedure and response	Games with simple rules
Access to the significance and meaning of children's stories with identification of main characters, plot, setting, conflict, resolution, theme, climax and genre	Is based on the picture that reflect the elements of the problem		Games that involve design of strategies (dominoes, naval battle, checks, China checkers, etc.)
Construction of written stories developing a continuity and coherence	Internalization of the guide		
Specific tasks of the program of neuropsychological intervention to attention deficit disorder [10]			

absence of severe mistakes of loss of information. Similar changes were detected in the tasks for audio-verbal retention.

TABLE 2: Tasks of visual retention: reproduction, evocation and evocation after heterogeneous interference in initial and final assessment.

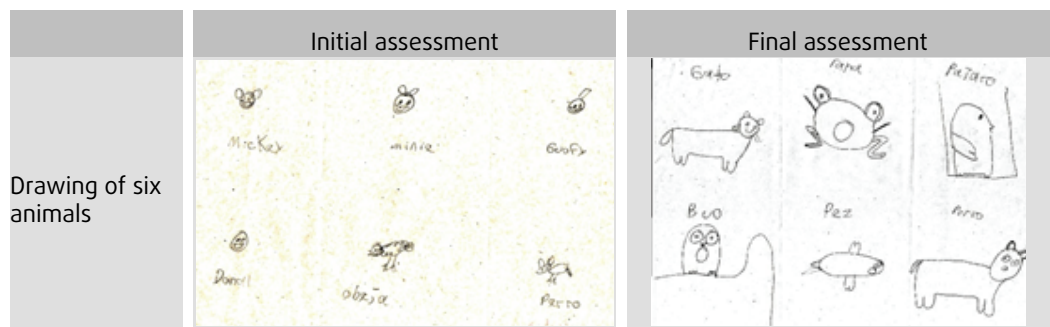
Model		
	Initial assessment	Final assessment
Immediate reproduction		
Evocation		
Evocation after heterogeneous interference		

In motor coordination neuropsychological tasks, a better performance was also observed. Reciprocal movements became more fluid, all motor sequences presented better organization without simplifications and intrusions.

Results of corrections showed important reduction of simplifications and anticipations in all verbal tasks. Better planning of actions oral and written was observed with better organization of abstract thought and access to meaning of sentences and texts. The number of errors of contamination, perseverations and intrusions to the tasks decreased.

Examples of such evidence might be observed in drawing tasks. The Figure 3 shows examples of drawing of six animals before and after the program of correction. It is possible to notice very similar pictures, which were difficult to recognize. On the contrary, the pictures drawn after correction presented proper organization and essential details of the animals.

TABLE 3: The task of drawing of six animals before and after correction.





Simplifications were typical errors observed during execution of drawing tasks in initial assessment. Significant improvement was noticed during final assessment (Fig. 3). Positive executions after neuropsychological correction allow to appreciate essential and differential elements in the girl's drawings.

Important changes took place also in intellectual tasks related to school learning, such as reading and copying words. It could be observed (Fig. 4) that before participation in the program of correction, constant omissions of accentuation marks were evident together with omissions of capitals letters, errors in the spatial distribution, omission of elements of words and multiple aggregations.

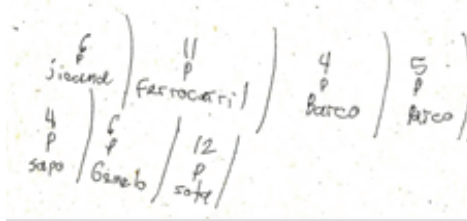
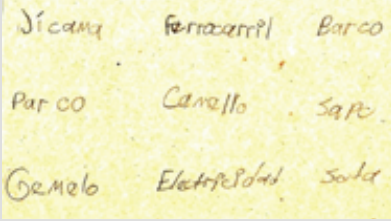
The executions of the girl after participation in the program shown the absence of such severe mistakes. The whole writing process were essentially improved. These improvements could be observed in different tasks, showing greater adherence to punctuation rules, accentuation, orthographic rules, adequate space distribution

TABLE 4: The tasks of free drawing of “boy” and “girl” during initial and final assessment.

	Initial assessment	Final assessment
Drawing of a boy		
Drawing of a girl		

between words, adequate intonation in reading and greater comprehension of written texts (Fig. 4).

TABLE 5: Executions of the task of copy and reading of words before and after program of correction.

Model	Jícama Ferrocarril Barco Parco Camello Sapo Gemelo Electricidad Sota	
	Initial assessment	Final assessment
		

The most important changes that could be observed in the sphere of voluntary activity. During initial assessment, the girl presented strong difficulties to join a common goal. She constantly refused to fulfil the tasks, showed distraction by non-relevant stimuli and alternative executions, especially, such mistakes were found in all writing tasks and planning activities. In the task of writing a short text in five lines, the girl showed total impossibility during initial assessment. On the contrary, the task was achieved correctly during final assessment (Fig. 5).

The main thing to highlight was that the own language of the girl has shown better semantic and syntactic organization. The girl became able to answer properly to

TABLE 6: The tasks of free writing before and after neuropsychological intervention.

Free writing
Initial assessment
Final assessment

conceptual questions and could solve arithmetic problems by herself. All these results indicate better functional stage of regulation and control in school intellectual actions.

EEG study before implementation of neuropsychological correction showed correspondence of functional state of the cerebral cortex to the norm of age together with the presence of bilateral functional changes at basal ganglia level, and deviated patterns on mesencephalic and brainstem level.

4. Discussion

The program of correction was based on the results of initial assessment, which permitted to establish neuropsychological syndrome of functional deficit of regulation and control, a low level of acquisition of learning activity at school and impossibility to fulfil the tasks directed to previously established goal. The girl need constant guidance and external help for realization of all kind of intellectual tasks typical for school age. Materialized external actions represented the zone of actual development of the girls, while the perceptive actions appeared as the zone of proximate development. These perceptive actions converted into the zone of actual development at the end of correction, while verbal tasks appeared within the zone of proximate development.

The authors of these article are convinced that the positive results of each program of neuropsychological correction in childhood are determined on the data of initial assessment an should include both psychological level of analysis together with neuropsychological [14–16].

These qualitative features of both assessment and correction cannot be found in other neuropsychological approaches, which tend to combine behavioural and cognitive aspects as if such aspects were isolated independent categories [17]. These methods are limited because the programs are normally focused on only one cognitive function such might be attention, writing or reading.

It frequently happens that both procedures of assessment and rehabilitation programs for children are rigid, excluding the use of any kind of help by neuropsychologist. The specialist only gives instructions to act but never acts together with the child. The inclusion of external aid, schematization and voluntary reflexion makes it possible to develop strategies that allow to achieve later independent way of fulfilment of intellectual activity by a child. In other words, the conception of the zone of actual and proximate development should be used not only as a classic citation, but as a real mean of clinical activity of neuropsychologists [18, 19].

All kinds of external aids might be provided in relation to the orientation of child's own activity during joint execution of interesting tasks. The work with the child should include joint execution of action according to the plan of realization of the action: material, materialized, perceptive, verbal or mental. All proposed actions should be based on the level and content of the psychological age of each child according to dynamic analysis of this concept such as social situation, general line of development, basic new psychological formations of age and its central activity [19, 20]. The absence of such concepts in the work of neuropsychologist might conduct only achievement of partial results of adaptation to difficulties instead of valid development. Such adaptation never leads to generalization of the strategy of intellectual performance or the maintenance of the improvement.

Positive effects of proposed program of correction were obtained not only in the tasks which evaluate directly mechanisms of regulation and control, but also were observed in all tasks of neuropsychological assessment. In learning activity such as drawing, reading and writing positive results are also observed. All this data confirms Luria's thesis [21], who points out that psychological functions represent always systemic and interdependent organization and cannot be treated separately.

Our results clearly show advantages of systemic approach based on conception of activity theory applied to teaching [22, 23] instead of traditional psycho-pedagogical techniques addressed to only one symptom.

The authors would like to express that EEG analysis might be as a supporting tool for the conclusions about brain mechanisms and structures involved in each concrete syndrome. The problems of regulation and control mechanisms might be related, in some cases, to the dysfunctional state of various subcortical structures, for example, the basal ganglia, such as has been found in this research. Other authors [24, 25] have highlighted the physiopathology of the caudate nucleus and its associated circuits (basal ganglia) with diagnoses such as ADHD.

Present research shows that the third functional block cannot be limited only to the level of frontal orbital cortex, as several researchers have claimed. Participation of deep subcortical structures and structures responsible for motor organization and movements should be taken into account. EEG is one of useful tools, which might help to understand complex and dynamic participation of brain cortical and subcortical participation in syndrome, which we observe during the process of ontogenetic development [6, 25].

The authors are convinced that it is possible to attribute the effectiveness of the program of neuropsychological correction to the content of the program based on theoretical-methodological conception both in psychology and neuropsychology.

5. Conclusions

- The application of the program of neuropsychological correction allowed to obtain positive changes in the functional status of regulation and control, which was observed in all tasks of neuropsychological assessment: motor, verbal, kinesthetic, graphic and retention in different modalities.
- Positive changes were observed in intellectual activity at school such as reading, writing and calculation.
- It is possible to find cases of children with learning disabilities with diagnosis of ADHD and functional deficit in the programming and control mechanism with dysfunctional level of subcortical structures as ganglia, mesencephalon and brainstem origin together with positive cortical functional general state corresponding to the age norm.

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