Application of Luria's Theoretical-Methodological Principles for Evaluation in Infants with School Difficulties in Math: a Case Study of Epilepsy

Aplicação dos Princípios Teórico-Metodológicos de Luria para Avaliação de Crianças com dificuldades Escolares em Matemática: um Estudo de Caso de Epilepsia

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Abstract

The objective of the present study was to discuss the theoretical and methodological principles recommended by Alexsander Romanovich Luria and their application to neuropsychological and educational assessment in infants. We present a case study of a male child, 11 years of age, diagnosed with generalized idiopathic epilepsy absence with a history of school in mathematics. The neuropsychological evaluation followed four steps proposed by Luria: (1) qualitative analysis of the symptoms, (2) quantitative evaluation of activity, (3) qualitative evaluation of activity, and (4) the proposition of a rehabilitation program. These steps were contemplated based on a neuropsychological protocol composed of nomothetic and idiographic tasks. We found deficits in manipulation activities, especially ones that demand visuospatial and visuoconstructive skills, associated with school difficulties in mathematics. The Lurian method allowed us to identify preserved and compromised cognitive functions, allowing interventions that minimized the identified deficits.

Keywords: Neuropsychological Assessment. Mathematical Activity. Luria. Epilepsy Absence. Childhood.

Resumo

O objetivo do presente estudo foi discutir acerca dos princípios teórico-metodológicos recomendados por Alexsander Luria e sua aplicação para a avaliação neuropsicológica e educacional infantil. Apresenta-se um estudo de caso de uma criança do sexo masculino, 11 anos de idade, diagnosticado com epilepsia idiopática generalizada do tipo ausência com histórico de dificuldades escolares em matemática. A avaliação neuropsicológica realizada seguiu os quatro passos propostos por Luria: (1) análise qualitativa do sintoma, (2) avaliação quantitativa da atividade, (3) avaliação qualitativa da atividade, e (4) a proposição de um programa de reabilitação. As etapas aludidas foram realizadas a partir da utilização de protocolo composto por tarefas nomotéticas e idiográficas. Foram identificados déficits em atividades manipulativas, notadamente aqueles que demandaram habilidades visoespaciais e visoconstrutivas, associadas com dificuldades em matemática. O modelo luriano possibilitou a identificação de funções cognitivas deficitárias e preservadas, além de proposição de intervenções que minimizaram os déficits identificados.

Palavras-chave*: Avaliação Neuropsicológica. Atividade Matemática. Luria. Epilepsia de Ausência. Infância.*

1 Introduction

Neuropsychology, as a science which investigates and acts on injuries or dysfunctions frameworks on the brain, is increasing its recognition in scientific community, remarkably by developing effective intervention programs that allows to reestablish and/or to compensate cognitive functions affected by traumatic neurological events or even functional disturbances.

When it comes to neurological alterations in childhood and adolescence, some peculiarities are seen as challenge to clinical practice, as well as the cognitive functioning investigation, whose subject of analysis is a nervous system in continuous development, inserted in a context of alterations which modify its maturational course through the action of reorganization mechanisms (Muszkat & Mello, 2008).

Thereby, it is considered that the planning of an effective rehabilitation program in youth neuropsychology needs a strict process of previous evaluation which considers the dynamical character of neurodevelopment, maturational processes and the cognitive changes in course. For this purpose, it is necessary to develop effective methods of neuropsychology diagnosis, able to subside the structuring of rehabilitation plans which reflects in the child's and family's quality of life (Tranel, 2005).

Therefore, neurodevelopment study in pathological conditions demands the adoption of a comprehensive referential, which allows the study of individual cases, according to a theoretical model about the nervous system and its functional organization (Haase, Chagas, Gonzaga, Mata, Silva, & Géo, 2008). This finding is turning feasible and desirable the approach between developmental neuropsychology and cultural-historical neuropsychology project, in particular, from the contributions of Alexandr Romanovich Luria. The theoretical-methodological assumptions of Cultural-Historical Neuropsychology is based on a development perspective which comes from the comprehension of how natural processes, such as physical

maturation and sensorial mechanisms, connect with cultural processes, making it possible to emerge higher psychological functions (Luria, 1992).

In light of this, it is highlighted the primordial foundation of this perspective: social context is the great development factor (Figueira, Cró, & Lopes, 2014) once it is constituted as origin of higher mental processes. Therefore, the development of the child's mental processes occurs through the shared experience, in social interaction (Veresov, 2010), once the brain do not build in a separate way mental processes, in which the social context has crucial role in the development and in the organization of brain activity (Vygotsky, 1991).

In a context of distorted development or disontongenesis, sensorial incapacities and neurological impacts do not constitute as main problem, but their social implications do, once these alterations become "atypical" only when inserted in a social context. It is the social that modifies the development course of the child, once expectations, attitudes and atmosphere created by society impact the injured child access to sociocultural knowledge, to experiences and to the opportunity to participate in common activities or shared with the others (Gindis, 2003).

Consequently, to Cultural-Historical perspective, rehabilitation strategies are designed to dominate mental tools and use them to get cultural methods of behavior (Gindis, 2003), once they reorganize all the structure of psychological functions and, necessarily, emerge on the process of cultural development of higher mental functions (Veresov, 2010).

In turn, the Lurian propositions with regard to the principle of extracortical organization of mental functions arose as an outcome of the impasse generated by the dispute between localization arguments and antilocalization arguments, which cause polemics with regard to relationships between brain and behavior. Luria proposed an alternative for this debate, launching a conception of science that was simultaneously in line with neurophysiological tradition and the humanist perspective in the comprehension and understanding of clinical conditions (Hazin, Leitão, Garcia, Lemos, & Gomes, 2010, Kristensen, Almeida & Gomes, 2001). Concomitantly, he presented a reformulation of the conflicts with regard to psychology between the nomothetic and idiographic approaches, resulting in the development of a peculiar conception of neuropsychological phenomena and consequently the proposition of evaluating such an equally innovative phenomenon. The components of Luria's theory and methodological principles that were proposed in the mid-20th century still resonate and direct theoretical and methodological advances in contemporary neuropsychology.

Among the central theoretical principles of Luria's neuropsychology, noteworthy is the proposition of its characteristic functional systems: in the face of a constant (invariable) task, different mechanisms can be accessed (variability), leading the process to a constant final result (invariable). A complex composition of the functional system will always have afferent and efferent impulses (i.e., information is received, and responses, diverse in nature, are provided by the subject). The functional system does not have an exact cortical location (i.e., it is not confined to determined brain areas, although one can mention cortical areas that are important for each of the systems) (Luria, 1981).

Gathering with the theoretical principles proposed, the model of Lurian neuropsychological evaluation gives important base to the investigation of neurological alteration frameworks in childhood, once it contemplates the clinical history of the patient, the observation on behavior aspects and results gained through application of neuropsychological tests (Glozman, 1999).

To Luria, the neuropsychological evaluation process demands a detailed analysis aiming to comprehend which cerebral mechanisms are related to compromised mental functions in a functional system (Eliam, 2003). In other words, evaluation aim to identify fundamental deficits or associated factors to visible deficits coming from the mapping of strong and weak points of cognitive functioning, investigating preserved and compromised functions under the light of the theoretical model of functional systems (Haase, 2008, Hazin *et al.,* 2010).

For this purpose, this diagnosis model does not limit itself to the investigation of only one affected function. Its methodology assumes qualitative analysis of the investigated symptom, through the appreciation and comparison of primaries alterations with secondary alterations, in other words, those which comes from as a result of systemic organization of the higher psychological functions (Glozman, 1999, Luria, 1981). Such approach has two implications: a) neuropsychological evaluation is flexible and can be adapted to each patient; b) the examiner has to have wide knowledge, not only about psychometric, but also of cerebral organization of cognitive activity, neurology, neurophysiology, neuroanatomy and general psychology, in order to orient and reorient the evaluation process.

In this way, considering the relevance of clinical ability and syndromic analysis in neuropsychological evaluation, the evaluation methodology of Luria assumes four necessary and complementary steps to the compliance of the goals that bases its diagnosis and interventional comprehension, as so: 1) Qualitative analysis of the symptom; 2) Quantitative Analysis; 3) Qualitative evaluation of the activity; and 4) Rehabilitation Program.

This model of evaluation may focus on the processual character of analysis in detriment of exclusive appreciation of obtained results and scores through psychometrical tests. In other words, the emphasis consists on strategies used by the examinee when doing determined activities, as well as in the type of the error committed, aiming to a better comprehension of the deficit nature and the symptomatic expression as one

(Eilam, 2003, Luria, 1981).

It does not mean, however, the irrelevance of the usage of standardized tests to the evaluation process. According to Glozman (1999), quantitative evaluation of the symptom is very important to identify dynamic modifications in the cognitive functioning during neuropsychological supervision, besides making possible the measurement of results caused by therapeutic processes.

For that matter, the proposed steps in this evaluation model highlight the complementarity of qualitative and quantitative analysis between them, as far as they constitute themselves as comprehensive and flexible paths of investigation of the patient's cognitive functioning. Therefore, it is necessary the description of each one of these steps aiming to a better methodological explanation.

The first step consists of the *qualitative analysis of the symptom,* performed through investigation, analysis, and comparisons of primary alterations (those immediately related to the deficit factor) and secondary alterations (those that arise as a result of the systematic organization of superior psychological functions) (Glozman, 1989*)*.

In the second step, the continuity of the process is advanced through *quantitative evaluation*. In this context, validated and standardized tools are used to investigate the patient's global cognitive functioning. The proposed tasks in the neuropsychological evaluation cannot be limited to the investigation of a single function because the syndrome can consist of symptoms that, at first glance, appear heterogeneous but are linked to a specific brain area that is a component of diverse functional systems (Luria, 1981).

In the third step, a *qualitative analysis of the activity* is performed. It begins with consideration of the existence of a *continuum* between quantitative information derived from scores obtained on psychometric tests and qualitative information. The latter are obtained through observation and analysis of the structure of each task, the errors produced, and anticipation of the conditions that minimize or overcome the identified deficits (i.e., the strategies utilized by the patient to compensate for the impairments caused by the deficit) (Glozman, 1989, Luria, 1981).

The fourth step concerns the proposition of the principal object of the neuropsychological diagnosis (i.e., the planning of a rehabilitation program). For Luria, the rehabilitation of mental function is possible by reconstructing or structurally reorganizing the affected functional system (Luria, 1981). This reconstruction can occur in three different ways: (1) spontaneous brain reorganization, (2) compensation, and (3) the insertion of external auxiliary resources that substitute for the compromised skills.

With the objective of illustrating childhood neuropsychological practices based on the theoretical and methodological principles of Luria's model, we present below a case study that describes and characterizes each constitutive step in the process. It was performed in 10 sessions (~60 min each) in a room that was appropriated for clinical care in the clinic of infant epilepsy at the public hospital to which Hugo (pseudonym) was accompanied.

Given the procedural nature that characterizes evaluation in this model, the steps will be described concurrently with presentation of the results so the reader can follow the logic of each step because there is no *a priori* establishment of scripts and lists of tasks and tools that are to be used.

2 Clinical Case

2.1 Clinical and sociodemographic data

The clinical case presented herein is of Hugo, a male child diagnosed with generalized idiopathic epilepsy absence type - GIEAT, 11 years of age in the sixth year of elementary school in a public school in a city in northwestern Brazil. The first signs of the disease were observed in his first year of life when Hugo had several episodes of fever seizures that gradually evolved into absence crisis, identified and diagnosed when he was 6-7 years of age. The GIEAT is characterized by a lack of neurological lesions (idiopathic) and the presence of epileptiform discharges that affect the cortex (generalized), causing temporary suspension of consciousness (absence) (Gomez-Ibañez, McLAchlan, Mirsattari, Diosy & Burneo, 2017).

With regard to developmental aspects, the person responsible for Hugo informed us that his neuropsychomotor development during infancy occurred within the parameters of normality. However, during the preschool period, the school reported the first complaints of inattention. Starting in Elementary School I, difficulties in mathematics were noted, and school performance in this discipline was the principal complaint of the parents and school.

2.2 Neuropsychological diagnosis

2.2.1 Qualitative analysis of the symptoms

Anamnesis with the parents and application of a questionnaire about the parents' feelings, beliefs, and knowledge about epilepsy. Hugo's parents answered questions that involved the clinical record of the child's disease, pregnancy antecedents, motor development, language development, school life, daily routine, and family antecedents. The questionnaire was included as a source of information about the feelings, beliefs, stigmas, and knowledge of the parents about epilepsy.

The global analysis of the responses suggested overprotection and a current fear of a crisis outbreak, which led to a modification of family function. Notably, the parents emphasized that they believed in the existence of a relationship between epilepsy and the school difficulties faced by Hugo, notably in mathematics, and this was the central focus of the complaints.

Production of drawings and elaboration of stories in relation to the subject. In this phase, Hugo was invited to

produce drawings and write a story about them. Four topics were provided: "Me," "Mathematics," "Me and mathematics," and "How is it to have epilepsy?" The objective of this phase was to explore his representations about himself, epilepsy, and mathematics. We identified that he considered mathematics an important discipline, even with the difficulties he presented in the daily school routine. With regard to epilepsy, he expressed his anger and dissatisfaction, writing in one of the activities about his perceptions of the disease: "Epilepsy is too bad. I have epilepsy. At least there is a remedy called depaquene."

2.2.2 Quantitative analysis of the symptoms

Neuropsychological evaluation. At a different time, we performed a quantitative analysis by administering a set of tools (psychometric tests and activities) based on the initial analysis and composed of a battery of neuropsychological evaluations. Glozman (1999) highlighted that the quantitative evaluation of cognitive deficits is a primary step to evaluate the impact and dynamics of modifications in cognitive functioning caused by lesions or dysfunctions. Below we describe the tools we used and the respective areas investigated.

- Wechsler Intelligence Scale for Children-III (WISC-III): Intelligence (total IQ, verbal IQ, executive/manipulative IQ) and factorial indices (verbal comprehension, perceptual organization, resistance to distraction, and speed of processing.
- Rey Auditory-Verbal Learning Test (List of Words): verbal memory.
- Test of the Complex Figure of Rey-Osterrieth: visuospatial skills/visual memory.
- Trail Making Test (Trials, parts A and B), Stroop Test, and Test of Concentrated Attention (CA): attention (concentrated, divided, and alternated) and executive functioning.
- Test of School Performance (TSP): scholastic knowledge (arithmetic, reading, and writing).

Evaluation of mathematic activity. To understand the extension and characteristics of Hugo's school difficulties in mathematics, a "Tool of Evaluation of Mathematic Activity I" was created according to tools developed for analysis in Brazilian public schools because Hugo frequently attended this type of school. Such a positioning is justified by the following aspect. We sought to diagnose the child's difficulties within his own school reality to subsequently offer another type of evaluation using another tool that isolated the conceptual domain of the cognitive skills involved in the execution of a determined mathematical operation.

The tool was composed of 20 questions, created by copying from several other evaluation tools of the municipal, state, and national network and using questions proposed by researchers in mathematics education in addition to specific questions proposed in the present study. The tool encompassed different conceptual fields (Vergnaud, 1990) of school mathematics, notably the conceptual fields of additive structures (involving the concatenated use of addition and subtraction in problem-solving procedures) and multiplication (involving the concatenated use of multiplication and division). This tool also encompassed verification of the domain of algorithmic skills, such as those involved in setting up and executing algorithms to perform operations, combined with understanding the decimal numeral system. Additionally, in the domain of the conceptual field of structures of plane geometry (involving notions of symmetry) and the geometry of three-dimensional space (involving the translation and rotation of solids in a three-dimensional space), the tool consisted of questions about the special properties of geometric solids, requiring movement in space from the perspective of observation through the construction of a mental image. Finally, the tool proposed questions based on the knowledge of systems of common measures in the culture of the evaluated child. Notably, among the 20 questions that comprised the tool, seven were subsequently considered critical for the study because they mobilized aspects of visuospatial order that had a special focus on the comprehension of Hugo's cognitive possibilities and limitations (discussed below).

2.2.3 Qualitative analysis of activity

Qualitative analysis of the neuropsychological *evaluation.* Exploring Hugo's performance on the WISC-III, one can see that his overall results placed his intellectual capacity within the normal variation at the inferior median level, with the exception of the results obtained for execution IQ (79 points). We found that on this scale the worst performance was obtained in the subtest "Setting up objects," which evaluates the capacity of synthesis in an organized and integrated set and requires adequate perception, concentration, visuospatial manipulation, anticipation, and establishment of part-whole relations. The obtained weighted score was 3 points when the expected average is 10 weighted points ± 3 points. In this subtest, Hugo made a correct response for the first figure only, using little time (21 s of a total of 130 s available for the task). For the subsequent figures, Hugo spent all of the available time. Trying to set them up, Hugo rotated the pieces and changed the positions but could not identify what figure should be formed, completing only some junctions randomly. These results suggest the presence of difficulties in manipulation and visuospatial organization.

The performance presented by Hugo in the test of concentrated attention (CA) was consistent with the global results of the WISC-III. Hugo obtained 32 points, which indicates the classification of an inferior average, presenting only one error. This finding, together with his performance on the WISC-III, suggests more difficulty in visuomotor speed than the maintenance of focusing attention (concentration) or working memory because Hugo obtained his best performance in the subtests of the WISC-III that require such aspects of cognition ("Completing Figures" and "Digits").

The Trail Making Test evaluates the mechanism of attentional change (i.e., the ability to modify work with stimuli of different natures). In this test, Hugo performed the task without errors and within the time frame of Parts A and

B. His performance on Part B of the test, in which changes in attention are required (i.e., cognitive flexibility), corroborate the results within the expected parameters of the "Digits" subtest (in the inverse order) because this test investigates working memory and also cognitive flexibility.

On the Rey Auditory Verbal Learning Test, Hugo obtained performance above the expected performance in the task that evaluated immediate memory, corresponding to the recall of nine of 15 words that were read aloud. However, this pattern was not repeated in the subsequent recalls. In contrast, a commonly expected gradual increase in recall instead yielded to a decline. These results suggest difficulties learning consolidation, with significant losses of information after the presentation of a distractor as well as over time.

The TSP indicated low (inferior) performance in all of the evaluated aspects: reading, arithmetic, writing, and global performance. Hugo obtained the worst results in the arithmetic domain. Notable was the recurrence of errors made in setting up calculations. Even for calculations where Hugo needed to simply write the result and even when a correct response occurred, the organization of the responses was impaired, with no respect for the rule of the place value system.

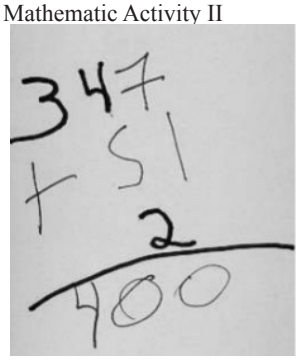
On the Rey Complex Figures test, which evaluates visuospatial and visouconstructive organization and visual memory, Hugo obtained performance below expected performance for his age (25th percentile) for both the copy task (18 of 36 points) and memory reproduction (8.5 of 36 points). Hugo's drawings drew our attention because of several aspects: (1) omission, both in copying and memory reproduction of significant elements of the drawing, such as a circle with three points, (2) overlapping of elements, present especially in the copy when the positions of the diagonals of a square were evaluated that were incorrectly drawn and appeared to have contributed to the disorganization of other elements of the quadrants, and (3) imprecision in the number of some elements, such as horizontal lines in the upper left quadrant, which was four, but Hugo drew seven lines that were obtained in memory reproduction.

Hugo's results on the Rey Complex Figures test are consistent with his low performance on the execution subtests of the WISC-III, namely "Set up Objects" and "Cubes." The finding of compromised visuospatial and visuoconstructive skills can explain the errors committed by Hugo in setting up calculations on the TSP, which required refined analysis of its production in the Tool of Evaluation of Mathematic Activity I.

Qualitative analysis of mathematic activity. Based on the results obtained in the previous steps, verifying the existence of visuospatial and visuoconstructive deficits in Hugo's protocols was possible. This conclusion is based on the analysis of errors and procedure he employed to solve problems that constituted elements of the Tool of Evaluation of Mathematic Activity I and the findings of the neuropsychological evaluation that pointed to a set of significant impairments in this domain. This fact culminated in asking a central question: Would the difficulties presented by Hugo in the execution of mathematical problems occur at the conceptual level (which was denominated competence-target) or procedural level (which was denominated competence-environment)?

To answer this question, a new investigation of the mathematic domain was proposed, contemplating visuospatial skills in an isolated form. We developed a Tool of Evaluation of Mathematic Activity II. This tool was set up based on mathematical games proposed by the Freudenthal Institute (http://www.fi.uu.nl), involving the principles of descriptive geometry and visualization of solids in two-dimensional representations and adaptations of neuropsychological tasks that involve visuospatiality. We also opted to reformulate the questions related to setting up and solving arithmetic calculations, in which some difficulties were observed, such as disrespect for the place value system in setting up addition and subtraction operations (aligning units, tens and hundreds; see Figure 1), to perform a procedural analysis of this activity. Therefore, the following domains were covered: symmetry (considered a skill to identify, analyze, and complete complex mirror images, considered herein a psychological precursor of the geometric-Euclidian concept of symmetry), rotation (based on the skill of rotating and translating mental images of solids in space), mental image and two- and three-dimensional construction (consisting of the skill to construct mental images of solids), and spatial orientation (related to the skill of representing and operating addition algorithms, notably in cases of operations that involve numbers with units, tens, and hundreds). Below we present some of the tasks, followed by considerations of the respective resolution procedures employed by Hugo.

Figure 1 - Extract of Hugo's procedure for question 4 of the Tool of Evaluation of Mathematic Activity II

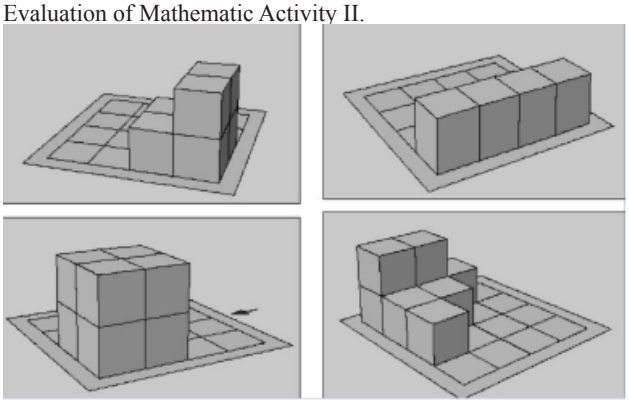


Source: Research data.

The problem presented below involved two- and three-dimensional mental construction, involving solids in two-dimensional space (stimuli printed on paper). This situational problem was based, with adaptations, on the game BUILD FREE proposed by the Freudenthal Institute and neuropsychological three-dimensional construction items that evaluate mental visuospatial manipulation skills. Posters that contained two-dimensional drawings formed by cubes (Figure

3) were presented. Initially, Hugo was asked to identify the number of cubes that comprised each of four figures that were presented. Subsequently, he was given fitting blocks (Lego™) and asked to reproduce the models that were represented in the printed figure using the cubes.

Figure 2 - llustration of the models of question 2 of the Tool of Evaluation of Mathematic Activity II.



Source: Authors.

Hugo was unable to either correctly respond to the question about the number of cubes in each of the presented stimuli (reproduced in Figure 2) or reproduce the models using the Lego™ blocks. Importantly, the results of previous research indicated that children of the same age and education level had 100% correct responses in the aforementioned situations (Hazin, Da Rocha Falcão & Leitão, 2006). These data emphasize the difficulties in the domain of mental image organization and two- and three-dimensional construction. The difficulties were also identified in tasks of special orientation but were not identified in the problems that involved symmetry.

Finally, posters that contained mathematical sentences were presented, in which Hugo had to set up and perform calculations on a white board or paper that was affixed to the board (example: 347 + 2 + 51). Trying to answer these questions, Hugo committed errors setting up the first two calculations, although he made correct responses (Figure 2). Importantly, Hugo closed his eyes at the moment of elaborating his responses and subsequently wrote the results. Such apparently unusual behavior was very clarifying. When asked why he closed his eyes while solving the proposed task, he answered, "Because if I see it I make an error!" When asked to explain how he performed the calculation, he said, "I put this [pointing to 347] with this [point to 2] and with this [pointing to 1] then it made 50, then I added and got 400." Therefore, we conclude that Hugo was not guided by the instrumental facilitator represented by the script-algorithm of the calculation to be performed (e.g., [20]; i.e., he did not count on setting up the calculation for an operation to reach a correct result, which was interpreted as difficulties in the visuospatial and visuoconstructive domains). At the same time, the strategy of composing numbers to solve the problems suggests that for Hugo, the principle of organization of numbers dominates, and Hugo performs operations by attending to the place of the decimal values because he does not recognize hundreds, tens, units, or rules about arithmetic operations in this domain.

The Tool of Evaluation of Mathematic Activity specially developed for this study allowed the mapping of Hugo's errors and an analysis of the procedures and difficulties he presented, which are probably similar to the ones faced in his daily school routine. During this step of the process, a subsequent effort was made to translate such results from working tools to teachers to reduce or even overcome these deficits (discussed below).

3 Rehabilitation Program

As discussed above, the process of neuropsychological evaluation based on the Lurian approach consists of interconnected phases that results in proposing a rehabilitation program. However, for this rehabilitation program to be feasible, a rigorous evaluation process is initially necessary that identifies preserved and compromised cognitive functions. Based on this evaluation, identifying the point(s) of the system that are impaired is possible, with the goal of determining a means to structurally reorganize the impaired system, thus minimizing or even overcoming the identified deficits.

The results of Hugo's evaluation are consistent with data from the literature with regard to the difficulties faced by children with idiopathic epilepsy absence type, namely deficits in the visuospatial and visuoconstructive domains. These deficits have a negative impact on learning mathematics in these children, which was a central symptom reported by Hugo's parents.

The principal difficulties presented by children with visuospatial and visuoconstructive deficits include oversights in counting numbers sequentially, problems constructing graphs or tables, difficulties transcribing numbers in Arabic numerals, difficulties recognizing mathematical symbols (e.g., $\leq$ and/or $\geq$), and being confused by symbols related to addition and multiplication calculations. As school requirements evolve, the difficulties experienced by these children are exacerbated, reflected by problems executing algorithms related to mathematical operations because of an inability to form a precise mental image of the positioning of the numbers and their respective decimal places.

The qualitative analysis of the typology of Hugo's errors in solving arithmetic operations suggests that his principal difficulties occurred at the procedural level (competence-environment) rather than at the conceptual level (competence-target). This distinction is crucial because it allowed advanced neuropsychological intervention in collaboration with the teaching staff at Hugo's school.

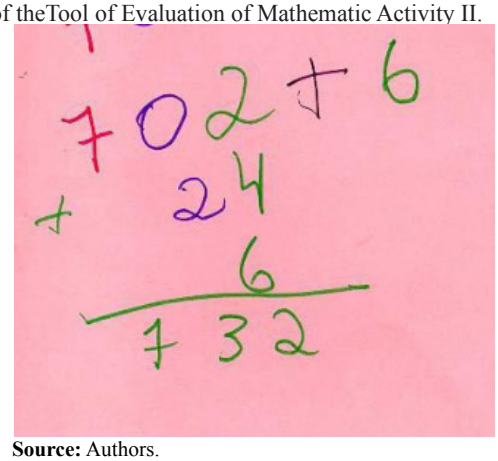
Based on discussions between the neuropsychologist and educators, a first form of intervention was elaborated, namely the use of colored pencils to set up calculations. Hugo was told that hundreds, tens, and units would have different

colors (green, blue, and red, respectively). The utilization of this resource is related to the principles of the Lurian approach, which considers the principle of the extracortical organization of mental functions and contends that it is possible to incorporate auxiliary mechanisms of the culture to allow subjects with brain abnormalities to obtain results that are similar to their peers. Thus, the neuropsychological interventions would overcome the limitations imposed by the spontaneous organization of the brain system, allowing the subject to build alternative strategies to minimize or overcome his deficits.

The implementation of this strategy was pursued in the following way. When the first calculation was presented with the colored numbers, Hugo was asked if he knew the meaning of each color. Initially, Hugo gave an equivocal but pertinent response. He observed the calculation 702 + 6 + 24 and said that green represents even numbers. Hugo was told that he was right, but he was asked if he sees another meaning for the colors. This time he was able to identify the hundreds, tens, and units. Such an aspect is critical for this analysis because it reaffirms the initial conviction the values in the tens place dominated with Hugo, thus reaffirming the hypothesis that the errors committed in setting up previous calculations were not competence-target (conceptual) errors but rather competence-environment (procedural) errors.

This hypothesis was confirmed when Hugo correctly set up calculations with the help of the colors (Figure 3). The aid of the colored pencils appeared to help with the adequate organization of the columns. The use of colored pencils was incorporated in Hugo's school routine. He was also provided other auxiliary resources, such as a grid notebook and a wooden board that showed place values. The colors were expected to be gradually internalized and incorporated into the mental images produced by Hugo to perform arithmetic operations.

Figure 3 - Extract of Hugo's performance on question 4 (part "b") of theTool of Evaluation of Mathematic Activity II.



Source: Authors.

Finally, the presented resources represent only an example of direction for a rehabilitation program, involving only one of the cognitive dimensions affected by GIEAT. An efficacious neuropsychological rehabilitation program needs to embrace the other cognitive domains affected by brain dysfunction, considering the systematic organization of superior cognitive functions and behavioral and socio-affective domains. Additionally, successful intervention requires an interdisciplinary team of various professionals that integrate the information obtained from evaluations with observations of activities of the child in his daily routine. Because it was beyond the scope of the present work, we limited the discussion to suggestions of specific resources, such as the use of concrete material and colored pencils to minimize Hugo's difficulties.

3 Conclusion

The significant prevalence of lesions or brain dysfunction in children has prompted the need to refine the neuropsychological process and create rehabilitation programs that are directed to this clinical subgroup. In this sense, Luria's theoretical contribution with regard to brain organization and function and the models of evaluation and rehabilitation he proposed based on the concept of functional systems and the principle of extracortical organization of superior cognitive functions can provide important insights into this line of investigation. The following are important developments in clinical psychology based on his work: (1) the relevant role attributed to the social-cultural dimension in the context of neurodevelopment and the process of rehabilitation in several situations of brain lesions or dysfunction, (2) the need to integrate qualitative and quantitative aspects in neuropsychological evaluation, delineating changes in the emphasis on the product and process, and (3) the proposition of neuropsychological rehabilitation programs that overcome the limitations imposed by the spontaneous organization of the nervous system, allowing the incorporation of auxiliary cultural resources (so-called "cultural prosthesis") that allow the subject to develop alternative strategies to minimize or overcome his deficits.

From this perspective, diagnosis should not focus only on the tasks that the patient can or cannot perform but rather on the overall quality of his activity (i.e., the alternative strategies he develops). Neuropsychological evaluation requires the consideration of a continuum between quantitative information from scores obtained on psychometric tests and qualitative information obtained from observing and analyzing the structure of each task, the types of errors that are produced, and the anticipation of conditions that minimize or overcome the identified deficits.

The present case study was developed based on Luria's precepts of neuropsychological evaluation that can be mobilized to diagnose and better understand the difficulties presented by epileptic children in the domain of school mathematics. Such precepts allow demonstration of the pertinence of the theoretical model that is represented by the principle of extracortical organization of mental functions

through the incorporation of auxiliary cultural resources that allow the child with epilepsy to obtain results that are similar to children with normal development. Thus, neuropsychological rehabilitation goes beyond the limitations imposed by spontaneous organization of the brain system, allowing the subject to confront and develop alternative strategies to minimize or overcome his deficits. Such aspects appear to be crucial for proposing ways to rehabilitate individuals with neurological disorders. Notwithstanding the interest in understanding cognitive function in any individual, with or without identifiable deficits, Luria's model of the developmental organization and function of brain systems encompasses all aspects of human functioning.

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