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Behavioral Sciences

Neuropsychological Rehabilitation of Attention: Single-Case Experimental Design

Diego Maciel-Lima[1] & Ana Paula Almeida de Pereira[1]

[1]*Universidade Federal do Paraná, Curitiba / PR, Brasil*

ABSTRACT – The relationship between pediatric epilepsy and attentional deficits has been shown in many studies. The present study aimed to develop a neuropsychological rehabilitation program for attentional processes in a 10-year and 7-month-old child with epilepsy and to illustrate how to evaluate its efficacy through visual analysis of graphed data. The intervention partially and specifically reduced the child's number of distractions during the observed activities. The methodology employed provides a framework for planning, implementing, and evaluating neuropsychological rehabilitation programs.

KEYWORDS: single case experimental design, neuropsychological rehabilitation, attentional process, children, epilepsy, single-case

Reabilitação Neuropsicológica da Atenção: Delineamento Experimental de Caso Único

RESUMO – A literatura aponta a relação entre epilepsia pediátrica e déficits atencionais. O presente estudo teve como objetivo desenvolver um programa de reabilitação neuropsicológica de processos atencionais de uma criança de 10 anos e 7 meses com epilepsia e ilustrar como avaliar a sua eficácia por meio da análise estatística de gráficos. A intervenção reduziu, de maneira parcialmente específica, o número de distrações da criança durante as atividades observadas. A metodologia empregada oferece uma estrutura para planejar, executar e avaliar programas de reabilitação neuropsicológica.

PALAVRAS-CHAVE: delineamento experimental de caso único, reabilitação neuropsicológica, processos atencionais, crianças, epilepsia.

Cortical dysplasia (CD) is a malformation disorder in cortical development resulting from genetic and epigenetic defects and/or ingestion of toxins during childbirth. In CD, the lamination of neurons is damaged, increasing the predisposition to epileptic seizures (Stafstrom, 2006). Epilepsy resulting from CD tends to be difficult to control with medication in around 60% of children and adolescents (Hauptman, & Mathern, 2012; Palmini, & Holthausen, 2013). Children with medication-refractory epilepsy may present a picture of cognitive degeneration because with each crisis several mechanisms of neuronal death may occur (Lorigados et al., 2013). In addition, this population presents a pattern of executive and attentional deficits in comparison with their peers (Kesselmayer et al., 2019; Verche et al., 2018; Wickens et al., 2017) which in the educational setting are expressed by inattention, agitation and impulsiveness (Cainelli et al., 2021).

Literature acknowledges the connection between attentional deficits, executive dysfunctions, and pediatric epilepsy; nevertheless, few Brazilian attentional rehabilitation research employs the Single Case Experimental Design (SCED). Furthermore, no Brazilian studies that use visual analysis of graphed data to evaluate the effectiveness of neuropsychological treatments in this population were found.

SCED refers to intensive studies of one or more individuals in which target behaviors are continuously measured at the same time as one or more interventions are experimentally manipulated. Instead of comparing the aggregate mean of groups before and after an intervention, the individual is used as his own control. Interventions are inserted at different times and the effect of each insertion on operationally defined target behaviors is assessed (Tate et al., 2016).

SCED is a method better suited to the peculiarities of neuropsychological rehabilitation research. First, in the domain of neuropsychological rehabilitation (RN), the fundamental prerequisites for an experimental study—such as Random sampling, double-blindness, and large samples—are either rarely or never met. Second, comparison between groups is more complicated in this research context because it is difficult to find completely homogeneous groups of people with brain injury. Third, although individuals with injuries may have similar cognitive profiles, their goals, priorities, and preferences may vary due to the existing rehabilitation paradigm. Fourth, it may be challenging to determine the degree to which improvements are attributable to the intervention when comparing groups' before and after. Fifth, there is not necessarily a correlation between the statistical differences found using these research approaches and their clinical and functional significance. (Covre, 2012).

The strength of SCED is that it enables the effectiveness of the intervention to be evaluated directly on target behavior in an ecological way, which is important given that the goal of rehabilitation is to increase social participation by reducing problems arising from cognitive deficits resulting from injuries (Wilson, 2020). Conventional rehabilitation research typically employs group techniques based on indirect measures of effectiveness (results from neuropsychological tests), which are only partially related to functionality. Moreover, individual differences that are significant in a clinical setting are concealed when grouping means are used. Conversely, at SCED, a customized plan that meets each client's needs can be created without sacrificing the methodological rigor required to ascertain whether the client is changing over time and whether these changes are related to the intervention, spontaneous recovery, or other non-specific factors. In contrast to group studies, where all participants must adhere to a strict protocol until the study's conclusion, with this method, it is possible to identify intervention failures and base clinical judgments on empirical facts regarding the client's response. SCED already offers the Single-Case Reporting guideline in Behavioural interventions (SCRIBE) Statement checklist (Tate et al., 2016) and the Risk of Bias in N-of-1 Trials (RoBiNT) Scale (Tate et al., 2013), which are comparable to CONSORT (Moher et al., 2012) and PRISMA-P (Moher et al., 2015).

SCED studies focused on attentional problems in children with epilepsy are scarce. Only one study (Martinez Gonzalez et al., 2014) employed cognitive-behavioral strategies in conjunction with a rehabilitation program on a 6-year-old child. The study's findings indicated that the child had improved performance in executive functions, visual memory and copying, attention and working memory tests (digits), and hyperactive behaviors had decreased (parents' reports). The parents reported that there was also functional gain (ADHD scale). However, the study is not considered a SCED because it did not involve baseline measurement or visual graph analysis.

Based on the methodology of Lane and Gast (2014), visual analysis of graphed data enables a more objective evaluation of the effects arising from the insertion of various treatments and their specificity through objective estimates based on medians. Therefore, the present study aimed to develop a neuropsychological rehabilitation program for the attentional processes of a 10-year-old child with epilepsy and demonstrate the application of a visual analysis of graphed data for evaluating the program's effectiveness.

METHOD

Design

The research design was multiple-baseline design, a type of SCED whose goal is to determine the functional relationship between changes in a target behavior and an intervention. In order to achieve this, it was necessary to choose a few activities that would be repeated throughout all sessions, to allow repeated and constant measurement of target behaviors (attentional function). This process was necessary to compute the baseline, incorporate one intervention at a time, and maintain a consistent assessment of the target behavior. Thus, we developed an intervention program that incorporated cognitive training and was centered on the development of self-awareness and compensatory skills based on these factors; the rehabilitation program section provides further information on this program.

Participant

V., 10-year and 7-month-old, male, was recruited from the Neuropediatrics Center of the Hospital de Clinicas in a Southern Brazilian city. According to the medical record, he was diagnosed with symptomatic partial epilepsy caused by focal cortical dysplasia in the left temporal lobe with secondary generalization resulting from unidentified delivery complications. The electroencephalogram (EEG) revealed changes in the left hemisphere's mesial temporal lobe, amygdala, and hippocampus, as well as changes from the anterior to posterior regions. He experienced three to four seizures per day that were resistant to medicine. There were no neuropsychomotor and verbal skills delays, but behavioral and cognitive issues began at age four, when epileptic seizures began.

Attention, hyperactivity, impulsivity, oppositional-defiant conduct, slowness in completing school tasks, and learning challenges in literacy and mathematics were all mentioned by the family and school. There had been a history of failure in the third year of school. In the WISC-IV (Rueda et al., 2011), his intellectual level was borderline (IQ=75), and in the Psychological Attention Battery (Rueda & Monteiro, 2013), his attentional performance was below average in focused and alternating attention, as well as divided attention.

Primary outcome

The main target behavior was the number of distractions in each cognitive training session as counted by the analysis of recorded sessions. Distractive behaviors were defined as those lasting more than 3 seconds in which the participant referred to elements outside of the task at hand, such as games or stories. The researcher did not record behaviors before or between tasks, while the next task was being organized. Questions about how to complete the task were not considered disruptive behavior.

The second goal behavior was the amount of time required to return to the activity after each distraction. The calculation was performed as follows: during the video analysis, the number of distractions, the minute of the video in which each of them happened, and the time it took to return to the activity of each distraction were all counted. For each session, the total time required to return to the task was added and divided by the number of distractions. For example, in session 1, when we added the time it took to return to the activity of each distraction, we got a total of 220 seconds. This amount was then divided by 11, the total number of distractions, yielding the value 20. As a result, the higher the number on this graph, the longer it took V. to resume normal activities after being distracted.

WISC-IV (Rueda et al., 2011), BPA (Rueda & Monteiro, 2013), and SNAP-IV scales (Mattos et al., 2006) were used. The first two were used to compare their cognitive performance before and after the session, as well as to determine whether the abilities learned during the intervention were applicable to the target cognitive processes. The second scale assessed the intervention's effect on the frequency and severity of symptoms of inattention, impulsiveness, and hyperactivity. Frequent behaviors were attributed two points, whereas very frequent behaviors were attributed three points.

Procedure

The study received ethical approval from the Ethics Committee of Hospital de Clínicas of the Federal University (022420/2015). Five cognitive training tasks were developed and described in the Cognitive Training Program section. The goal was to replicate monotonous school tasks and measure the target distraction behavior at baseline and after the intervention. Until session eight, just cognitive training exercises were employed, with no intervention. The same tasks were repeated in all 16 sessions.

The neuropsychological rehabilitation research suggests using ecological methods to quantify dependent variables (Wilson, 2020), which entail evaluating the target behavior in participants' daily lives, like counting the number of distractions the child faces while doing homework at school or at home. However, parents and teachers' potential lack of adherence and reliability in monitoring desired behavior may render the research unreliable. For example, research that relies on informants like parents and teachers to determine the frequency of distracting behaviors may be biased. These informants may account for more or fewer distractions than the total number of distractions. This bias has the potential to undermine the study's internal validity. As a result, it was necessary to measure the target behaviors only during sessions.

All sessions were recorded to ensure a reliable measurement of the number of distractions and the time it took to return to activities after distraction. The recordings were then evaluated, and a table was created with the following information: the number of distractions each session, the minute of recording when the distraction began, and the minute of recording when the distraction finished. In order to reduce the evaluator's subjectivity, four videos (25% of the total) were selected at random and separately evaluated by another previously trained observer.

Kazdin (2011) recommends that at least 20% of films be examined by another impartial observer. Sessions 3, 4, 7, and 8 were studied, and the exact agreement rates were 45.45%, 66.66%, 70%, and 100%, for an average agreement rate of 70.52%. Exact agreement means that cases in which the independent observer identified the distraction in the same situation (minutes and seconds of video) were considered correct.

Rehabilitation program

The current rehabilitation program was developed using the clinical attention model of Sohlberg and Mateer (2010) and the working memory model of Baddeley (2010), from which five cognitive training exercises were derived. This intervention is characterized as one that employs precisely designed and behaviorally constrained learning experiences dispersed in a repeatable and hierarchical fashion with the ability to improve brain systems or cognitive functions (Keshavan et al., 2014).

Task 1 is the mental calculation of basic mathematical operations with visual support, which means that the numbers are visibly given on a sheet and the subject executes the mental operations from there. The things are structured in a hierarchical order, beginning with the easiest items to add units and progressing to adding and subtracting tens. The most important parameters of this task are the percentage of calculations completed in five minutes (out of 100) and the percentage of right responses. The first parameter measures processing speed, while the second reflects processing speed. This activity seeks to improve visual-focused attention, working memory, and processing speed. Activity 4 is similar, except it focuses on the phonological loop of working memory.

The electronic game (fruit ninja, task 3) serves the dual purpose of testing attentional features while motivating children. In this mobile game, the player must cut the appearing fruits (processing speed). As the game advances, new fruits arrive. If the player drops three fruits, he will lose the game. Bombs can sometimes be found among the fruits. If the player cuts a bomb, he loses the game, requiring inhibitory control.

The N-x back procedure, used in activities 2 and 5, was created by Cicerone (2002) and showed positive results in the rehabilitation of attention and working memory in adults with mild TBI. The N-x backwards procedure involves showing the participant a sequence of playing cards and then asking him or her to remember which card came before the last one. The number of cards rapidly grows in a varied manner (6, 7, 4, 8, 10, 7) such that you cannot recall or guess which card to remember. In order to complete it successfully, participants must pay attention during the presentation. The task also needs a continual shift of attentional focus. For each item, participants must concentrate on the cards displayed. However, when the researcher shuffles the cards, the subject can defocus their attention, which must be refocused when the new object is shown. These qualities of the activity act as a discriminative stimulus for distractions, increasing the likelihood of the participant becoming distracted. The work was designed as a game to sustain motivation and a pleasant atmosphere. V. was awarded one point for each correct answer, whereas the researcher received one point for each incorrect answer. Although the first person to reach 10 points would win, the activities were designed to ensure that the participant won every time.

Task 5 is an adaptation of Cicerone's (2002) N-x back task. This activity is comparable to 2, but in verbal mode, meaning that a random and pre-determined series of numbers is dictated verbally rather than using cards. In order to raise the complexity of tasks 2 and 5, you can increase to N-2. This means that instead of being asked to recall the previous number, in N-2, they were asked to remember two numbers before the past one, and so on (N-3 and N-4).

The initial goal of Intervention B was to help V. become more aware of his distractions and how much they interfere with his performance. As a result, beginning with session 8, he was asked to define distraction in his own words at the start of each session. The definition of distraction was then presented complete with illustrations and role-plays. Intervention B followed the "toothpick" methodology. Each time V. became distracted, the researcher warned him and drew a line on a blank sheet of paper. Table 1 outlines cognitive functions addressed in cognitive training, goal behaviors, and intervention B.

Table 1
Description of cognitive functions worked on, performance measures and intervention

Cognitive functions cognitive training	Performance measures	Intervention B
Task 1: Visual focused attention, working memory and processing speed Task 2: Verbal focused attention, verbal working memory Task 3: Inhibitory control Task 4: Verbal focused attention, working memory and processing speed Task 5: Visual focused attention, visual working memory	Number of distractions per session Time to return to task after distraction	Psychoeducation about distraction, write down each distraction on a piece of paper

Visual analysis of graphed data procedure

Lane and Gast's (2014) visual analysis of graphed data technique was used for this study because it assures improved data reliability and prevents misinterpretations that can arise with only visual examination of SCED-generated graphs. In summary, the visual analysis of graphed data used tries to statistically answer the following questions: Are the data for each condition stable? If not, do the data in each condition increase or decrease? Did the addition of the intervention impact the data? Is the transformation abrupt or gradual? Are changes in target behavior due to the intervention or other non-specific factors?

From condition A (baseline) to condition B (intervention B), there are two types of data analysis: the within and between-condition analysis. The within-condition analyses assess conditions A and B separately within each category. The purpose of this index is to confirm the trend and stability of the data in each scenario. Before inserting treatments, the data must reach a certain degree of stability to ensure that changes are not due to spontaneous improvement or non-intervention-specific causes.

The initial stage in a within-conditions analysis is to calculate the number of sessions in each condition. Next, the mean and median are determined. The next step is to compute 25% of the median, which is known as a standard error.

This means that an interval of the median plus and minus this 25% value is computed. For example, if the median is 28.5, 25% of that value equals 7.125. The range is 28.5 minus 7.125, which is 21.375, and 28.5 plus 7.125equals 35.625. In this situation, the range is 21–35.625. The next step is to calculate the percentage of values inside this condition that fall within the range. If more than 80% of the data falls inside this range, it can be considered stable. If the percentage is less than 80%, the data is considered variable. This approach decreases the likelihood of errors that can occur in the visual inspection of graphs without statistical procedures, when the researcher subjectively decides that the data is stable despite it is not actually occurring.

Two other concepts are important in within-condition analysis. There are two levels of change: relative and absolute. In order to compute the relative level change, subtract the median of the second half from the median of the first half of the same condition. This indicates that the data for the condition must be separated into two groups, each with a median. A high median level of change within the same condition indicates that there was a significant proportionate change without any intervention being introduced or changed. The second concept, absolute level change, is computed by subtracting the condition's final value from the first, and it represents the absolute size of the change without intervention. If these two indicators are positive even before the intervention is implemented, it is possible that the increase is due to the task learning effect rather than the intervention itself.

Whether, on the other hand, when comparing the intervention data to the baseline data, it is found that the data were decreasing prior to the start of the intervention but increased immediately and consistently after its insertion, the increase in the target behavior (attentional performance) can be associated with the insertion of the intervention. Next, if performance reduces when the intervention is withdrawn, it can be concluded more confidently that there is a functional relationship between the intervention and enhanced attention. For instance, if the purpose of an intervention is to increase the number of homework assignments a child completes in class, the first sign of an experimental impact would be an increase in homework completed soon after the intervention begins. If the intervention is discontinued and the number of tasks returns to the baseline level, there will be greater evidence of the intervention's association with the target behavior. On the other hand, if metacognitive strategies are provided and cannot be removed later, and A was decreasing before the intervention but increased immediately after its removal, it can be concluded that the participant continued to use strategies even after the researcher's mediation was withdrawn.

On the other hand, the analysis between-conditions examines the transition from A to B with the goal of determining the degree of change caused by the insertion or withdrawal of the intervention and whether it is related to the intervention. In order to do so, assess the relative and absolute levels of change. The first is computed by subtracting the intervention's first-half median from A's second-half median. This factor represents the degree of proportional change between the two circumstances. The absolute level change is calculated by subtracting the first value of the intervention from the last of A and indicates the absolute degree of change between the conditions. High values of this index suggest that the change was abrupt, while small values suggest that the immediate change was not abrupt. And finally, the percentage of non-overlapping data is calculated by determining the percentage of B values below the lowest baseline value. High values of non-overlapping data indicate greater magnitudes of change.

RESULTS

The effect of intervention on distracting behaviors

Before analyzing the data, one of the sessions was eliminated since the individual experienced an epileptic seizure during the session (see figure 1). In the within-condition analysis, the baseline data remained stable, with 85.7% falling within the 25% range of the median. The absolute change was -5, but the relative degree of change was +0.5 (see Table 2). Relative change metric is safer than the other because it takes medians into account. As a result, while the trend line was negative prior to the intervention, the reduction was not statistically significant. The difference between the trend line and the relative level of change within the condition can show how statistical analysis can overcome biases caused by visual analysis of graphs. The within-condition B analysis demonstrates that the results were variable following the introduction of the intervention. We concluded that both the trend line in Figure 1 and the relative (-7.5) and absolute (-8) decrease indicate a considerable reduction in the number of distractions following the implementation of the intervention (Table 2).

The introduction of intervention B resulted in a sudden increase in the number of distractions, as shown in graph 1, in the relative (+2.5) and absolute (+7) level of change in between-conditions analysis (Table 3). This increase can be attributed to the fact that, when V. was confronted with his distractions, the number of distractions per session rose. For example, when the researcher began to mark on the stick at each distraction, the subject objected since he did not completely see the significance of such marking. He felt punished because of a mistake. As a result, it took him longer to return to his activity, and he became distracted more frequently.

Table 2
Within-condition analysis of distraction per session

	Condition A	Condition B
Change (trend)	Deteriorating	Deteriorating
Relative change	+0,5	-7,5
Absolute change	-5	-8
Percentage of data within 25% of the median	85,7%	50%
Stability	Stable	Variable

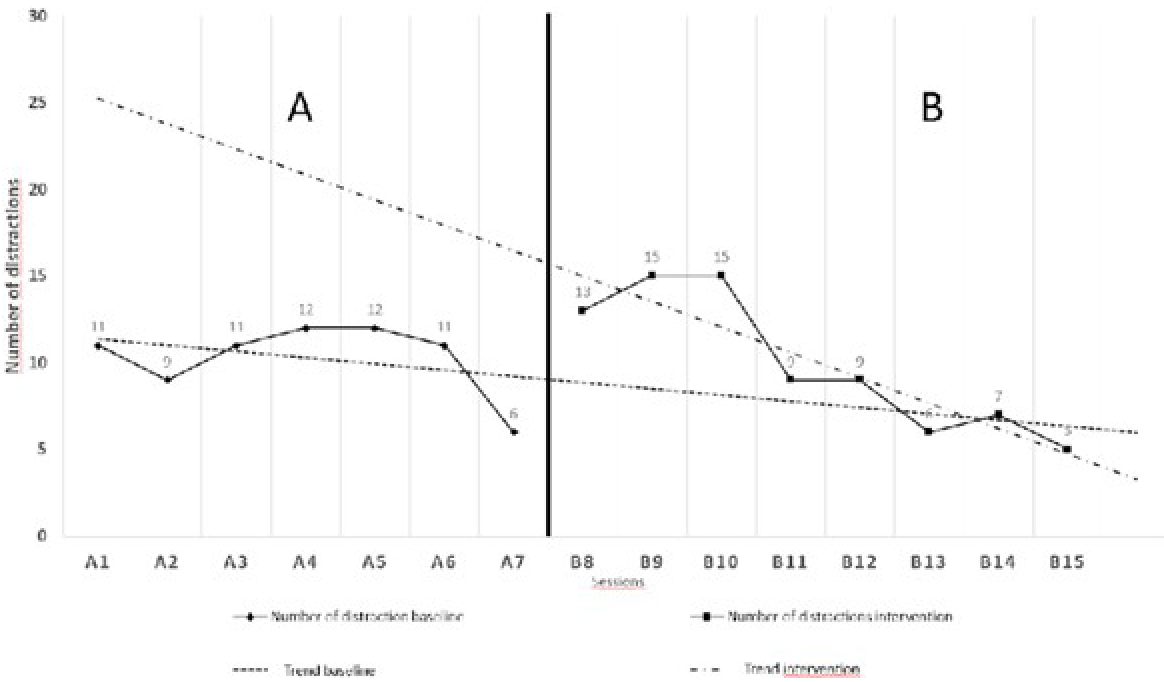

Figure 1. Number of distractions per session.

Table 3
Between-condition analysis of distraction per session

	A to B analysis
Relative level of change	+2,5
Absolut level of change	+7
Average level of change	- 3
Percent of non-overlapping data	12,5%
Percent of overlapping data	83,4%

However, as the intervention progressed, there was a significant gradual reduction in the number of distractions, as indicated by the change indices (-3) and trend line in Figure 1. However, the non-overlapping data index is low, with only 12.5% of the data from condition B falling below the lowest value from condition A. Session 7 had an unusually high number of diversions due to unclear circumstances. If it were eliminated from the analysis, the non-overlapping data rate would increase to 37.5%.

Data from session 3 were also removed to assess the time required to return to activities following distractions. Both the baseline and the intervention condition had variable data in within-condition analysis, with 57.14% and 37.5% of data within 25% range of the condition's median, respectively. In A, the negative trend line (Figure 2) and the levels of relative (-1.7) and absolute (-6) change show that time to return to activity was decreasing before the intervention (Table 4). However, the decline is more pronounced in condition B, according to the slope of the trend line (Figure 2) and the relative (-11.43) and absolute (-16) levels of change.

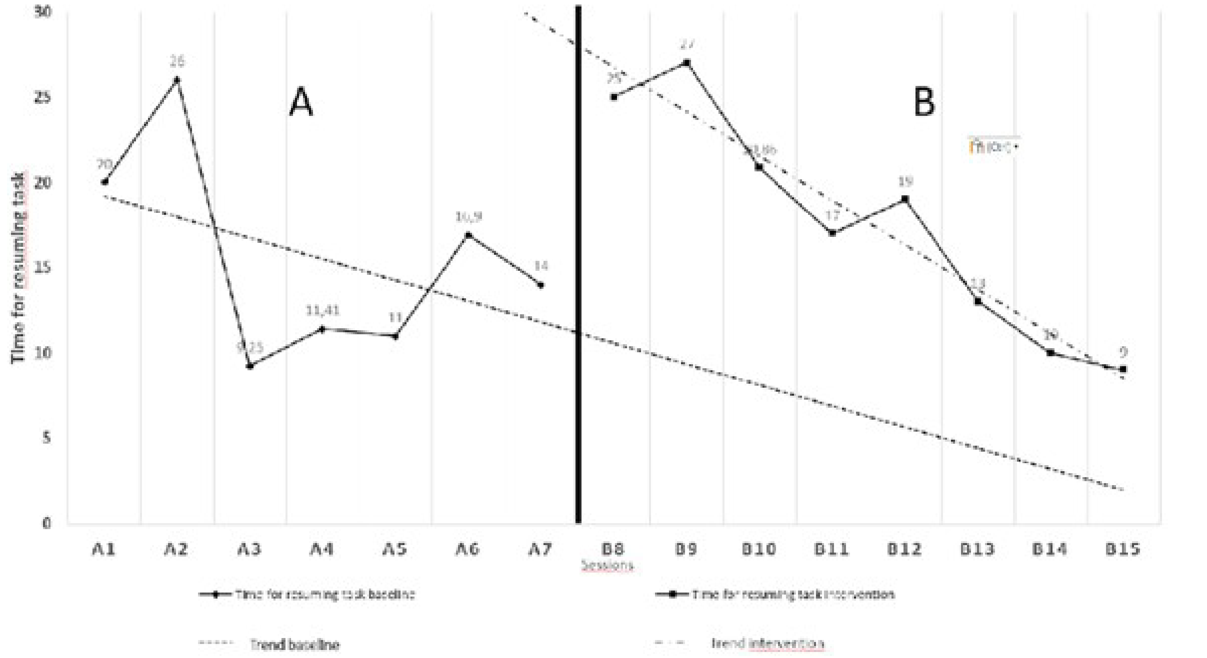

Figure 2. Average time for resuming task (seconds)

Table 4
Within-condition analysis of average time for resuming task

	Condition A	Condition B
Change (trend)	Deteriorating	Deteriorating
Relative change	-1,7	-11,43
Absolute change	-6	-16
Percentage of data within 25% of the median	57,14%	37,5%
Stability	Variable	Variable

Similarly to the number of distractions each session, the intervention resulted in a rapid and significant increase in the time to return to activities, as measured by the relative change level indexes (+14.5) and absolute level of change (+11) (Table 5). Unlike Figure 1, the average level of change between conditions A and B increased (+4), indicating that B median was higher than A. Finally, the non-overlapping data was 37% (Table 5). Overall, these findings indicate that there was a significant tendency toward a shorter time to return to activities following the implementation of the intervention. However, more sessions are required for the impact to settle.

Table 5
Between-condition analysis of average time for resuming task

	A to B analysis
Relative level of change	+14,5
Absolut level of change	+11
Average level of change	+4
Percent of non-overlapping data	37,5%
Percent of overlapping data	62,5%

Comparison of cognitive measures before and after intervention

When the pre- and post-intervention assessments are compared (Table 6), there was a small decrease in the raw and weighted scores of almost all subtests during the intervention period, as well as a significant reduction in the digits and matrix reasoning subtests, which reduced total IQ from borderline to an intellectual disability category. On the other hand, there was a slight improvement in the performance of focused and divided attention, a decrease in alternating attention, and a significant drop in the degree of complaints of inattention, hyperactivity, and impulsivity recorded by parents in SNAP.

Table 6
Pre- and post-intervention comparison

	RS	PB	RS	PP	IQ	IQ	BPA	BPA	SNAP	SNAP
	Pré	Pós	Pré	Pós	Pré	Pós	Pré	Pós	Pré	Pós
Block design	18	17	8	7						
Similarities	10	10	10	7						
Digit span	11	7	8	2						
Coding	12	12	2	1						
Vocabulary	18	14	6	4						
Matrix reasoning	9	3	6	1						
Symbol Search	13	7	8	4						
Picture Completion	13	20	6	9						
Information	11	9	8	4						
Arithmetic	12	15	5	5						
Comprehension			24	15	88	70				
Perceptual reasoning			20	17	79	73				
Working memory			13	7	80	62				
Processing speed			10	5	71	55				
QI Total			67	44	75	60				
Concentrated attention							40p	50p		
Divided attention							10p	30p		
Alternated attention							30p	20p		
Inattentive									23	10
Hyperactive-impulsive									26	14

Note. Adapted from Rueda, F. J., Noronha, A. P. P., Sisto, F. F., dos Santos, A. A. A., Castro, N. R., 2011. WISC IV - Escala de Inteligência Wechsler para Crianças. 4nd ed. São Paulo, SP: Casa do Psicólogo.*RS: raw score, WP: weighted points, IQ: Intelligence Quocient, BPA: Bateria Psicológica de Atenção (attention test), p: percentile, SNAP: ADHD Symptom Screening Scale (Mattos et al., 2006)

DISCUSSION

The current study sought to create a neuropsychological rehabilitation program for attentional processes in a child with epilepsy, as well as to demonstrate how to assess its effectiveness using visual analysis of graphed data. We found that intervention B consistently reduced the number of distractions, and the time required to resume activities. This effect was partially specific because the visual analysis of graphed data enabled the detection of small changes in the data that were directly related to the inclusion of the intervention. The specificity is partial because at least three additional examples must be replicated to increase confidence in the experimental results observed. Although the intervention did not improve the cognitive impairments associated with recurring seizures, it did reduce the degree of attentional symptoms from extremely severe to moderate, with a minor increase in focused and divided attention. It was unable to ascertain whether this effect was caused by the intervention or other variables.

These findings are consistent with previous clinical trials in which the researchers compared the effect of a cognitive attention training method (n=19) with an attention compensation method (n=17) on the cognitive performance and quality of life of adults with focal epilepsy (Engelberts et al., 2002). After 6 months, there were no significant changes in reaction speed and inhibitory control, and they concluded that the compensation method was more effective than cognitive training in improving self-report measures of life quality for individuals with low education. That is, both studies corroborate the observation that neuropsychological rehabilitation can increase the individual's functionality and adaptation to their environment, even if there is no improvement in cognitive functions.

Similar pattern was obtained from the current study. Despite the functional advantages from reducing distractions, several of his cognitive skills decreased after the intervention. If only neuropsychological tests were used to assess effectiveness, the intervention would be considered unsuccessful. In fact, contemporary rehabilitation literature suggests that efficacy measures and target behaviors should be closer to ecological and functional needs, rather than solely focusing on cognitive assessments and cognitive training (Cicerone et al., 2019, Wilson, 2020). After all, neuropsychological rehabilitation should attempt to promote client engagement in activities and goals that are relevant to them.

Therefore, SCED and visual analysis of graphed data offer a framework for cognitive rehabilitation. SCED enables the therapist to make intervention-related decisions based on empirical ecological data, personalize activities to the needs of each client/family without sacrificing methodological rigor, and assess the process effectiveness for each client. Visual analysis of graphed data also ensures objectivity in the analyses and lowers the likelihood of bias (Lane and Gast, 2014).

For instance, in this study, the response to intervention B could be assessed before the research ended. Based on the notion that the number of distractions was decreasing in a varied fashion, it would be conceivable, in a clinical situation without time constraints, to plan more sessions until the data stabilized. Another option would be to halt the intervention before the end of the research if the desired response was not achieved. These are examples of how the approach utilized enables clinical decision-making and the identification of what is not working during the process, which is not possible in group trials with closed protocols. Furthermore, these decisions would be based on empirical evidence, as statistical methods are used to identify data variability, relative or absolute change, reducing the clinician's subjective biases.

Another advantage of this design is that it enables you to deliver visual, fast, and consistent feedback on the customer's performance throughout the process. For example, when V. noticed that his number of distractions was decreasing, he was inspired to try to better manage himself in future sessions. Visual input is essential for establishing self-awareness in neuropsychological rehabilitation (FitzGerald, M et al., 2019).

SCED also enables us to isolate small components of bigger treatments and assess their effectiveness for specific participants as well as their impact on various target-behaviors. For example, in the current study, only the technique of increasing self-awareness and psychoeducation was assessed. Other studies have evaluated specific interventions such as step-by-step training protocols for using Google Calendar (Baldwin, & Powell, 2015) to reduce forgetting appointments in adults with Traumatic Brain Injury, patients with anosognosia reflected on videos of themselves as a way to promote self-awareness (Besharati et al., 2015), and technological reminder resources to increase the percentage of daily tasks performed in adults who have suffered a stroke (Boman et al. 2010).

In conclusion, one of the study's strengths was the use of ecological variables directly related to the participants' daily difficulties. The inclusion of videos, the operational definition of the goal behavior, and the interobserver correlation index improved measurement reliability and mitigated threats to the study's internal validity, which is one of the key drawbacks of SCED investigations. Another advantage was the adoption of a structured procedure to assess the effectiveness of the intervention. This was one of the first studies to apply visual analysis of graphed data (Lane and Gast, 2014) in neuropsychological rehabilitation research of Brazilian children. This methodology presents a practical framework for assessing the efficacy of future studies in neuropsychological rehabilitation.

However, the current study has the following limitations. First, more participants would be required to confirm the experimental effect found. According to international SCED consensus, the effect should be demonstrated in at least three participants or behaviors (Tate et al., 2013). Second, future research should examine the procedure for calculating the average agreement rate when monitoring target-behavior between the researcher and another trained observer. In the current study, we sought precise correspondence between observers, which resulted in an agreement rate lower than the 80% recommended in literature. Other agreement procedures could produce more accurate findings. Finally, further sessions were required to guarantee that post-intervention results remained stable.

CONCLUSION

In conclusion, intervention B reduced, in a partially specific way, the V. number of distractions and the time he took to return to activities, decreased the severity of symptoms in daily life, and increased focused and divided attention, despite the overall decrease in intellectual performance related with the frequent seizures These findings support prior observations that neuropsychological rehabilitation might result in functional gains without necessarily enhancing cognitive ability, emphasizing the importance of future efficacy research focusing on broader ecological metrics than just neuropsychological tests.

In this regard, SCED provides a framework for developing, implementing, and evaluating neuropsychological rehabilitation programs aimed at increasing the social involvement and life quality of people who have had brain injuries. SCED enables clinicians to make decisions based on empirical ecological data during the intervention, tailor activities to the needs of each client/family without sacrificing rigorous integrity and assess the process effectiveness for each client. Visual analysis of SECD graphs (Lane and Gast, 2014) ensures objectivity in the analyses and lowers the likelihood of bias.

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Associate Editor
José Eduardo Pandóssio

Corresponding author
Diego Maciel-Lima
Email: dmaciel.diego@gmail.com

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