



DESIGN AND NEUROERGONOMICS IN THE IDENTIFICATION OF ATTENTION-RESTORING ELEMENTS FOR CHILDREN WITH ADHD IN EDUCATIONAL SETTINGS

Layane N. de Araújo, M. Sc.^{1*}

Marcelo M. Soares, Ph.D.²

Abstract

This work aimed to support a doctoral thesis in development whose theme is: the application of Design and Neuroergonomics in the identification of elements that restore the attention of children with ADHD in educational environments. To this end, a Systematic Literature Review was carried out in order to search for studies that addressed children and/or adolescents with ADHD, in the learning/attention process in educational environments, in the light of Neuroergonomics and the Theory of Restorative Environments. The searches took place in the CAPES Journal Portal and the PRISMA method was used for this purpose. The filters used were only articles published in the last 5 years (2016 - 2021), peer-reviewed, in English and Portuguese. A total of 166,419 articles were found, of which the first 100 of each combination were analyzed by title and abstract. After dynamic reading of the works, 14 articles remained divided into two groups: group A of greater relevance and B of lesser relevance. The articles in group A correlated the attention and learning of children with ADHD, suggesting and applying interventions of pedagogical and/or technological procedures to assist in the teaching and learning process of this audience. The works in group B addressed the experiences of professional educators and students with ADHD in the teaching environment. No works were found that correlated all the points sought, especially the 'Theory of Restorative Environments' with ADHD, thus proving the need to expand the search in future RSL works, and that there is much room for new studies in this field.

Keywords: Systematic Literature Review, Design, Neuroergonomics, Theory of Restorative Environments, ADHD.

1. INTRODUCTION

Attention Deficit Hyperactivity Disorder (ADHD) is a neurobehavioral disorder of genetic causes that occurs in childhood and often accompanies the individual throughout his or her life. According to the Brazilian Association of Attention Deficit (2020), ADHD affects 3% to 5% of children in various regions of the world, and in more than half of cases the disorder remains in adulthood.

¹ PhD student in Design, Federal University of Pernambuco. * layane.araujo@ufpe.br.

² School of Design, Hunan University, P. R. China.



According to Arruda et al. (2015), approximately 912 thousand Brazilian children between 5 and 12 years old were diagnosed with ADHD, but without any type of clinical treatment. However, another 625 thousand minors, 2.3% of the total, do not even know about the existence of the neurological disorder.

One of the main complications associated with ADHD is related to concentration problems and consequently learning (ARRUDA ET AL., 2015, p.5). This fact highlights the need for specialists to focus their attention on these individuals in educational environments, based on the child's right to go to school, participate, interact and develop.

Thus, the present study aims to contextualize Design in its multidisciplinary approach, establishing its connection with Neuroergonomics, ADHD and the Theory of Restorative Environments, in order to contribute both to these fields and to Design itself.

For the development of this research, a bibliographic survey was carried out, through a Systematic Review of the Literature, with the main objective of supporting the author's own doctoral thesis in development, in the Graduate Program in Design of the Federal University of Pernambuco.

In the following topic, the theoretical foundations guiding this research will be explained.

2. DESIGN, ADHD, NEUROERGONOMICS AND RESTORATIVE ENVIRONMENTS

For a better understanding of the concepts of Design, Ergonomics, ADHD, Neuroscience and the Theory of Restorative Environments, this topic is divided into two parts. The first part, which follows, aims to establish a relationship between Design, Ergonomics and teaching environments, and the second part, further on, sought to highlight the connection between ADHD, Neuroscience and the Theory of Restorative Environments.

2.1. Design, ergonomics and educational environment

Design is a word that has a Latin origin, *designare*, which means to develop, to conceive (BÜRDEK, 2010). The designer conceives artifacts, environments and services. For Beat Schneider (2010):

Design is the creative and systematic visualization of the processes of interaction and messages of different social actors; it is the creative and systematic visualization of the different functions of objects of use and their adequacy to the needs of users or to the effects on receptors (SCHNEIDER, 2010, p. 197).



Thus, Papanek (1995) stresses the importance of removing designers from the comfort of their offices and making them observe real social needs, considering that experiences are fundamental to form a design professional.

Therefore, Design comprises a multidisciplinary field that encompasses social, anthropological, psychological, marketing, ergonomic aspects, among others. As Ergonomics is one of its areas of study, it is understood as an indispensable process to combine Design and Ergonomics in practices of social and educational interventions, since according to Iida (2016), ergonomic requirements make it possible to maximize the comfort, satisfaction, and safety of the user. According to ABERGO (2000):

Ergonomics is characterized as the study of people's interactions with technology, organization and the environment, aiming at interventions and projects that aim to improve, in an integrated and non-dissociated way, the safety, comfort, well-being and effectiveness of human activities (ABERGO, 2000).

Thus, ergonomics is understood as an area that aims to transform and adapt, not only work, but space to the different needs of human beings, taking into account their limitations and characteristics.

Therefore, the combination of Design and Ergonomics can bring benefits to projects related to the educational environment, because according to the *International Ergonomics Association* (IEA, 2021), through data collection and ergonomic analysis, it is possible to identify physical factors - linked to anatomy, anthropometry, physiology, and biomechanics of the user and the activity analyzed; cognitive - such as mental processes, that use aspects of the user's perception, memory, reasoning and motor response in relation to the activity performed; and organizational - which evaluates, in a holistic, systemic and integrated way, the environment of activities, the relationship between the constituent parts of the organization, the workflows and the schedule of the processes.

Furthermore, the National Guidelines for Special Education in Basic Education, presented by the Ministry of Education (MEC) (2001), states that it is not the student who molds or adapts to the school, but it is the school that, aware of its function, makes itself available to the student, becoming an inclusive space (BRASIL, 2001).

In view of these statements, Askina (2016) argues that the teaching environment must be effective to contribute to the *successful* adaptation of children with ADHD to the schooling



process. In addition, Harrison et al. (2019) state that Design interventions in the educational environment can provide improvements in the quality of teaching and learning for these children.

The deepening of ADHD, the concept of Neuroscience and the Theory of Restorative Environments will be addressed in the following topic.

2.2. ADHD, neuroscience, and restorative environment theory

Arruda et al. (2015) define ADHD as a neurobiological disorder, usually genetic and hereditary, characterized by a dysfunction in the prefrontal cortex, part of the brain responsible for decision-making, action planning and control of emotions, which directly influences children's cognitive and behavioral abilities.

The ADHD spectrum brings together cases with different variations of the neurological disorder, and the NeuroSaber institute (2016) states that all care offered during childhood can be able to minimize the complications associated with ADHD, since children with ADHD often have a low performance index in school environments (KUHNEN AND PUFF, 2014, p. 35). These complications, in turn, can be related to the child's behavior and mood (aggressiveness, excitability, anxiety, hyperactivity, restlessness, irritability, or lack of moderation) and cognition (problems with difficulty concentrating, forgetfulness, lack of attention, and learning difficulties).

In addition, there are several multidisciplinary areas that are interested in studying human thought and behavior, such as Environmental Psychology, Cognitive Psychology, and Neuroscience. According to Paiva (2018), the last two added to Ergonomics, result in Neuroergonomics.

According to Parasuraman and Rizzo (2007), Neuroergonomics converges concepts from the disciplines of Neuroscience and Ergonomics, and aims to study the brain and human behavior in the performance of activities, emphasizing the context of cognition and behavior of individuals in everyday environments. That is, the Neuroergonomics approach invests in the studies of neural structures to, through brain functioning, affirm or refute, the prediction of tasks performed (PAIVA, 2018, p. 120).

According to Paiva (2018), human activities developed in physical spaces are mediated by human cognition and perception in relation to these spaces, in order to optimize the physical, psychological and emotional needs required by users for these environments. Therefore, it is clear that Design, when combined with Neuroergonomics, can be understood as a factor that



constitutes a device that aims at physical and psycho-emotional well-being, capable of expanding human capacities and potentialities.

For Bins Ely (2003), the influence of the built environment on the behavior of the individual is related both to the requirements of the task to be performed in the environment, as well as to the characteristics and needs of the user. This is justified when the physical environment responds to the needs of users, both in functional (physical and cognitive) and formal (psychological) terms, resulting in a positive impact on the performance of activities. In view of this, the environment can provide a restorative space that helps in the behavior, conduct and performance of its user.

Thus, the concept of *restorative environment*, an original term from Environmental Psychology, is used to describe the process of feelings aroused by the environment, which can have a positive influence on the health and well-being of the individual (ALTMAN & WOHLWILL, 1983; KAPLAN & KAPLAN, 1982; KORPELA, 1989).

Thus, Oliveira et al. (2019) emphasize that a welcoming/restorative educational space should promote the health of students, and constitutes an important public health issue, with personal, environmental, social, and institutional impact. And Kuhnen and Puff (2014), in their studies with children with ADHD, state that the school environment should favor participation and learning, since the role of the environment is one of integration, attention and learning.

Therefore, in order to better support the study and identify other more recent studies in the literature that better addressed the theme in question, bibliographic searches were carried out in the databases of the Periodicals portal of the Coordination for the Improvement of Higher Education Personnel (CAPES).

The methodological procedure adopted for data collection was the Systematic Literature Review (RSL). The search method will be described in the following topic.

3. METHOD

The Systematic Review was developed based on the PRISMA method - *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (SALAMEH ET AL., 2020).

The study comprised a systematic review of the qualitative and analytical nature, since it deeply evaluated the information collected, in an attempt to explain the selected works that addressed the theme of: children and/or adolescents with ADHD, in the learning/attention



process in educational environments, teaching strategies and Design interventions in classrooms, in the light of Neuroergonomics and the Theory of Restorative Environments.

The CAPES database of journals was used as a source of consultation, selected due to the considerable inclusion of journals in the performance of their searches: Scopus (Elsevier), SciELO (CrossRef), MEDLINE, PubMed (NLM), among others.

To this end, the following keywords were used as descriptors: "Neuroscience, Ergonomics, Neuroergonomics, educational environments, schools, learning process, learning, teaching, classrooms, Design, Interior Design and Restorative Environments, combined with the terms ADHD and Attention Deficit Hyperactivity Disorder", and in some cases with the terms "*NOT* Treatment" and "*NOT* Medicine". In English, the terms "Neuroscience, Ergonomics, Human Factors, Neuroergonomics, educational environments, school, learning process, learning, teaching, classroom, Design, Interior Design, Restorative Environment, combined with the terms ADHD and Attention Deficit Hyperactivity Disorder" were used, and in some particularities with the terms "*NOT* Treatment, *NOT* Medicine and *NOT* Drug".

The search was filtered only with articles published in the last 5 years (2016 – 2021), peer-reviewed, *that is, only for articles evaluated by at least two reviewers*, in English and Portuguese. The Inclusion and Exclusion criteria of the analyzed studies were:

- *inclusion* – articles that addressed the theme of children and/or adolescents with ADHD in the teaching environment; studies focused on the learning of children and/or adolescents with ADHD; studies that addressed teaching strategies and design interventions in classrooms for children and/or adolescents with ADHD, in the light of neuroergonomics and/or the theory of restorative environments;
- *exclusion* – studies that have adults with ADHD as a sample; studies that address only clinical pathologies and/or use drugs in analysis and treatment; studies that deal with conditions other than and/or combined with ADHD, such as Autism Spectrum Disorder (ASD).

The searches took place in four stages, as illustrated in Fig. 1.





Figure 1. Steps of RSL based on the PRISMA method.
Source: author (2021)

The first stage comprised the general search for articles in the CAPES Journal Portal, using the pre-defined filters. The search returned a grand total of **166,419** articles in Portuguese and English. To carry out the searches, the categories Any – Any were chosen, which brings together all the other categories offered by the platform: search in the Title, search for the Author and search in the Subject.

The *Boolean* operators selected for the searches were '*and*' and '*not*' since the use of the *Boolean* '*or*' did not generate results directed to the study. In addition, the search for keywords was done in pairs, since the attempt to combine in trio, using the *Boolean* '*and*' returned very few results.

Thus, to form the combinations, the descriptors were alternated always combined with the terms ADHD or Attention Deficit Hyperactivity Disorder, and in some particularities accompanied with the Boolean '*not*' in order to exclude articles that addressed

only drug treatments and use of drugs. The combinations of keywords used in the searches can be seen in tables 1 in Portuguese and 2 in English, respectively.

Table 1. Searches in the Portal of Periodicals, articles – CAPES – Terms in Portuguese

Search Category: Any – Any Keyword / Boolean / Keyword	Return (number of peer-filtered articles)
Neuroscience <i>and</i> ADHD	7
Neuroscience <i>and</i> ADHD <i>not</i> Treatment	6
Neuroscience <i>and</i> ADHD <i>not</i> Medicine	6
Neuroscience <i>and</i> Attention Deficit Hyperactivity Disorder	4
Neuroscience <i>and</i> Attention Deficit Hyperactivity Disorder <i>not</i> Treatment	0
Neuroscience <i>and</i> Attention Deficit Hyperactivity Disorder <i>not</i> Drug	0
Ergonomics <i>and</i> ADHD	0
Ergonomics <i>and</i> Attention Deficit Hyperactivity Disorder	0
Neuroergonomics <i>and</i> ADHD	0
Neuroergonomics <i>and</i> ADHD <i>not</i> Treatment	0
Neuroergonomics <i>and</i> ADHD <i>not</i> Medication	0
Neuroergonomics <i>and</i> Attention Deficit Hyperactivity Disorder	0
Neuroergonomics <i>and</i> Attention Deficit Hyperactivity Disorder <i>not</i> Treatment	0
Neuroergonomics <i>and</i> Attention Deficit Hyperactivity Disorder <i>not</i> Drug	0
Educational Environments <i>and</i> ADHD	4
Educational Environments <i>and</i> Attention Deficit Hyperactivity Disorder	0
Schools <i>and</i> ADHD	18
Schools <i>and</i> Attention Deficit Hyperactivity Disorder	6

Learning Process <i>and</i> ADHD	21
Learning Process <i>and</i> Attention Deficit Hyperactivity Disorder	12
Learning <i>and</i> ADHD	35
Learning <i>and</i> Attention Deficit Hyperactivity Disorder	21
Teaching <i>and</i> ADHD	29
Teaching <i>and</i> Attention Deficit Hyperactivity Disorder	14
Classroom <i>and</i> ADHD	13
Classroom <i>and</i> Attention Deficit Hyperactivity Disorder	9
Design <i>and</i> ADHD	64
Design <i>and</i> Attention Deficit Hyperactivity Disorder	3
Interior Design <i>and</i> ADHD	0
Interior Design <i>and</i> Attention Deficit Hyperactivity Disorder	0
Restorative Environments <i>and</i> ADHD	0
Restorative Environments <i>and</i> Attention Deficit Hyperactivity Disorder	0
Total	272

Table 2. Searches in the Portal of Periodicals, articles – CAPES – Terms in English

Search Category: Any – Any Keyword / <i>Boolean</i> / Keyword	Return (number of peer- filtered articles)
Neuroscience <i>and</i> ADHD	5.355
Neuroscience <i>and</i> ADHD <i>not</i> treatment	1.944
Neuroscience <i>and</i> ADHD <i>not</i> medicine	2.490
Neuroscience <i>and</i> ADHD <i>not</i> drug	3.322
Neuroscience <i>and</i> Attention deficit hyperactivity disorder	5.586
Neuroscience <i>and</i> Attention deficit hyperactivity disorder <i>not</i> treatment	1.710
Neuroscience <i>and</i> Attention deficit hyperactivity disorder <i>not</i> medicine	2.273
Neuroscience <i>and</i> Attention deficit hyperactivity disorder <i>not</i> drug	3.000
Ergonomics <i>and</i> ADHD	99
Ergonomics <i>and</i> Attention deficit hyperactivity disorder	118
Human Factors <i>and</i> ADHD	9.670
Human Factors <i>and</i> Attention deficit hyperactivity disorder	10.366
Neuroergonomics <i>and</i> ADHD	8
Neuroergonomics <i>and</i> ADHD <i>not</i> treatment	4
Neuroergonomics <i>and</i> ADHD <i>not</i> medicine	4
Neuroergonomics <i>and</i> ADHD <i>not</i> drug	7
Neuroergonomics <i>and</i> Attention deficit hyperactivity disorder	12
Neuroergonomics <i>and</i> Attention deficit hyperactivity disorder <i>not</i> treatment	8
Neuroergonomics <i>and</i> Attention deficit hyperactivity disorder <i>not</i> medicine	8
Neuroergonomics <i>and</i> Attention deficit hyperactivity disorder <i>not</i> drug	9
Educational environments <i>and</i> ADHD	1.836
Educational environments <i>and</i> Attention deficit hyperactivity disorder	1.740
School <i>and</i> ADHD	15.463
School <i>and</i> Attention deficit hyperactivity disorder	14.633
Learning Process <i>and</i> ADHD	7.811
Learning Process <i>and</i> Attention deficit hyperactivity disorder	7.959
Learning <i>and</i> ADHD	15.367
Learning <i>and</i> Attention deficit hyperactivity disorder	16.525
Teaching <i>and</i> ADHD	3.147
Teaching <i>and</i> Attention deficit hyperactivity disorder	2.980
Classroom <i>and</i> ADHD	3.308
Classroom <i>and</i> Attention deficit hyperactivity disorder	3.078
Design <i>and</i> ADHD	12.683
Design <i>and</i> Attention deficit hyperactivity disorder	13.093
Interior Design <i>and</i> ADHD	111



Interior Design <i>and</i> Attention deficit hyperactivity disorder	95
Restorative Environment <i>and</i> ADHD	151
Restorative Environment <i>and</i> Attention deficit hyperactivity disorder	174
Total	151.368

The second and third stages, filtering by title and by abstract, respectively, were carried out in parallel, since, many times, only by analyzing the title of the work it is not possible to infer the content covered by it. Thus, in this phase, the titles and abstracts of the articles were analyzed in order to separate the most relevant ones. To this end, the first 100 most relevant articles of each of the 70 groups of combinations of keywords presented were evaluated, totaling 7,000 titles and abstracts analyzed.

After this analysis and selection of the papers, the exclusion of repeated papers was carried out at this stage, obtaining a total number of **91** papers, 10 of which were in Portuguese and 81 in English to be analyzed in speed reading in order to verify whether the content of the papers in question was really in accordance with the inclusion and exclusion criteria described above.

Of these studies, 1 study in Portuguese and 13 in English were selected, totaling **14** articles that best met the purposes of this research to be evaluated in full reading. In order to illustrate the revision up to this stage, a graphic scheme presented in Fig. 2 was developed.

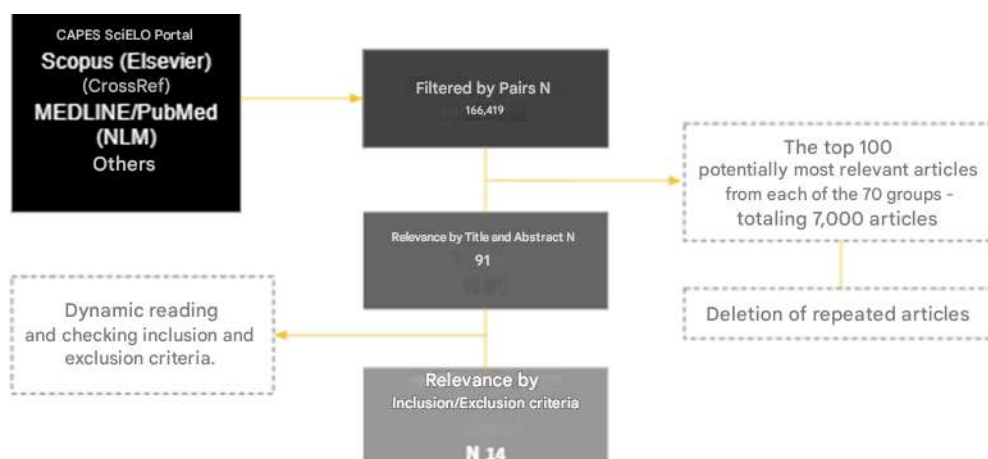


Figure 2. Steps 1, 2, and 3 of the RSL process.

Source: author (2021)

In the fourth and last stage, the complete reading of the selected works was carried out with the objective of analytically exploring the material. Based on the PRISMA method, the information of the works was systematized in an *Excel spreadsheet* with the following categories: title, author(s), reference, abstract, country of origin, object of study, objectives, methods and tools, results, conclusion and classification of relevance of the work.



This method made it possible to divide the articles into two groups: A and B. The criterion for this division was based on the degree of relevance of the content of each article in relation to the theme focus of this Systematic Review.

In group A there are the studies that explained greater relevance to the research, since they had a greater focus on the theme studied. In this group, the works addressed learning/attention processes of children with ADHD in classrooms, in the light of Design and Neuroscience interventions.

In group B are the studies that presented less relevance to the study. They talked about the teaching strategies adopted by teachers and early childhood educators in classrooms, and the experiences of students with ADHD. Each group will be detailed in the discussions of the following topic.

4. RESULTS AND DISCUSSION

In this topic, the works belonging to each of the groups: A and B will be presented.

4.1. Group A

In this first group, considered as the group for the most relevant works, 7 articles were analyzed that addressed the theme of this Systematic Review more specifically.

All seven studies were aimed at children with ADHD. Of these studies, three carried out learning assessments in individuals through pedagogical and technological procedural interventions (Mohammadhasani et al. (2018); Nazer (2017) and Barnett (2017)); two studies presented pedagogical approaches to teaching and interventions in educational settings through literature reviews (Adaskina (2016) and Harrison et al. (2019)); and two studies had a technological approach, with a greater bias in the application of Neuroscience (Garcia-Zapirain et al (2017) and Janssen et al. (2017)).

The results of the studies are better described, respectively, in the following subtopics.

4.1.1. Pedagogical and technological approach

Mohammadhasani et al. (2018) achieved positive results by investigating how a pedagogical agent can improve the learning of students with ADHD by applying a computer-assisted instruction (CAI) system: *Koosha*, with the aim of supporting children's learning by obtaining and directing attention to relevant information in classrooms. The study comprised an experimental design, pre- and post-test with a control group, applied to a population of 30



male students with ADHD in the primary school of northern Iran. The authors proved that the use of the pedagogical agent can favor the learning of students with ADHD.

Nazer (2017) focused on training in modeling and reinforcement of attention, selected and divided, academic improvement and self-efficacy of elementary school children with ADHD, in spelling and mathematics, using an academic self-efficacy questionnaire and a selected and divided attention software. The research method was a quasi-experimental design with pre- and post-test and follow-up with a control group. The survey sample consisted of 40 children chosen by the random sampling method of elementary school with ADHD from the city of Rafsanjan, Iran. As a result, the author showed that the training improved the amount of attention span of children, but was not significantly effective in the reaction time and academic self-efficacy of children with ADHD.

Barnett (2017), in turn, presented environmental, organizational and instructional techniques, as well as technology applications, to be used by teachers to improve the sustained attention and academic performance of children in the educational environment. This American study aimed to show the need to create an equitable and improved learning environment in the growing era of digitalization, in order to meet the attention needs of students with ADHD and other students who struggle with attention in the classroom.

4.1.2. Pedagogical and bibliographic approach

Adaskina (2016) conducted a literature search for studies with accentuated psychopedagogical aspects, that is, those that examined the factors that contribute to the success of the adaptation of children with ADHD to schooling and provide specific guidance on the various aspects of the educational process. This Russian study addressed effective ways of presenting content in the classroom, knowledge tests for children with ADHD, and the importance of more effective classroom environments. It was concluded by the author that behavioral techniques proved to be very effective in the process of correcting behavioral and educational problems of children with ADHD.

Harrison et al. (2019) presented, through a Systematic review of meta-analysis, evidence of Design research interventions implemented in classrooms, with students with ADHD, of four types: behavioral, instructional, self-managerial, and environmental. In this American study, the authors observed that classroom interventions for students with ADHD were moderately effective, and instructional Design interventions aimed at achieving academic outcomes were more effective when implemented in special education settings.



4.1.3. Technological approach with a neuroscience bias

Garcia-Zapirain et al. (2017) developed and tested, in this Spanish study, a dual system for the rehabilitation of the cognitive functions of children with ADHD on a technological platform developed from the "framework.net", using two sensors

physiological factors: the *Tobii X1 Light Eye Tracker*, an eye tracker, and the *Leap Motion*, a manual gesture recognition sensor, in order to improve the learning and attention of this audience. The system was tested by 19 children. It was concluded that the developed system can help children with attention deficit and learning problems. In addition to assisting teachers in monitoring and progressing their students.

The seventh and last study evaluated in this group, Janssen et al. (2017), used the EEG (Electroencephalography) tool with the objective of reducing ADHD symptoms using *neurofeedback*³. This Dutch study was conducted with 38 children previously diagnosed with ADHD. Users performed an average of 29 sessions of *Theta /Beta*⁴ neurofeedback training. The effects of learning were analyzed during and between the sessions in order to correlate the behavioral effects of these children with the learning curves. As a result, it was identified that there is no correlation between the learning curves of Theta/Beta waves and the behavioral changes of children with ADHD during *neurofeedback sessions*.

Therefore, there are several contributions of this first group to the study, from approaches to pedagogical interventions to technological interventions. Therefore, it is perceived that Neuroscience can contribute to the behavioral and attention assessment of children with ADHD through technological tools, such as EEG (Electroencephalography) and *Eye Tracking*, and these devices, together with Design and Ergonomics techniques, can constitute an important device for the identification of the elements that restore the attention of these children in teaching environments.

However, although these studies have addressed criteria of Learning, Attention, Neuroscience and Design with children with ADHD, based on the filters previously presented, no articles were found that related Ergonomics and the Theory of Education.

³ Neurofeedback is a treatment whose main objective is to improve brain functioning through non-invasive autoregulatory neuromodulation, and is indicated for the management of various neurological dysfunctions, such as ADHD (BARBOSA AND SILVA, 2021).

⁴ According to Janssen et al. (2017), at the behavioral level, the theta wave has been negatively related to alertness, while beta has been positively related to attention. Thus, one of the most commonly applied neurofeedback protocol goals is to decrease theta activity (4-8 Hz) and increase beta activity (13-20 Hz) (JANSSEN ET AL., 2017, p. 2).



Restorative Environments with Design interventions in the educational environment for children with ADHD.

4.2. Group B

In the second group, 7 articles were also analyzed. Although these studies present learning processes of children with ADHD in classrooms through mainly qualitative research, these studies were considered less relevant because they do not address intervention criteria of Design, Ergonomics, Neuroscience and the Theory of Restorative Environments.

Of the seven studies, only one presented a group of adolescents with ADHD as a sample (Wiener and Daniels, 2016), the others had children with ADHD as their target audience.

The first study analyzed focused on students with ADHD. It brought together important testimonies and school experiences of these students in relation to the learning processes (Wiener and Daniels, 2016); In the following five studies, the experiences, knowledge, and training of educators regarding students with ADHD were portrayed (Souza, 2016; Mohr-Jensen et al., 2019; Greenway and Edwards, 2020; Dwarika and Braude, 2020; and Moore et al., 2017); The last work, on the other hand, raised an important discussion about the exclusive teaching applied to ADHD, in contrast to the criteria of inclusive education (Malmqvist and Nilholm, 2016). The studies are better explained sequentially below.

4.2.1. Focus on students with ADHD

Wiener and Daniels (2016) present a portrait of the school experiences of adolescents with ADHD, in the context of a quantitative research, on teachers' attitudes and practices, adolescents' own self-assessment and their social and family relationships. This American study was conducted with twelve adolescents with ADHD. Semi-structured interviews were applied addressing the main aspects of the students' school life and three main themes were raised by them: (a) performance deficit, (b) academic and social engagement and (c) transition from dependence to independence. As a result, the authors suggest that educators should apply evidence-based interventions to provide greater academic support to these students.

4.2.2. Focus on educators

Souza (2016), through a single case study with a student diagnosed with ADHD, carried out in a public school in the city of Sinop - Brazil, aimed to understand the difficulties encountered in the learning process of this student, based on the teacher's teaching methodology. Data were obtained through observational methods and questionnaires with



teachers. Thus, the author concluded that there is a constant search for education professionals to provide better teaching-learning conditions for students with ADHD, amid the challenges caused by this condition.

Mohr-Jensen et al. (2019) aimed to identify what Danish primary and secondary school teachers know about ADHD in children and also to identify which factors predict this knowledge. To this end, a 29-item questionnaire on ADHD was applied, distributed to a random, national and representative sample of 528 elementary and high school teachers. As a result, most teachers recognized the symptoms of ADHD and were able to propose effective intervention strategies in the classroom. However, the authors stressed that they still need to acquire knowledge about the etiology, prognosis, and treatment of ADHD so that they can improve the management of children in the teaching environment.

Greenway and Edwards (2020) used Mulholland, Cumming, and Jung's (2015) scales of knowledge (SASK) and attitude (SASA), ADHD training, and perceived support in the classroom, to compare public school teachers and teaching assistants. The British survey was carried out with a sample of 165 teachers and 157 teaching assistants. As a conclusion of the research, the authors indicated that both teachers and assistants exhibited adequate levels of knowledge. However, teaching assistants had better knowledge about ADHD than teachers. Regarding training, it was found that both professionals need more improvement in the area.

Dwarika and Braude (2020) aimed to provide a description of teachers' understanding of ADHD and their classroom experiences. The South African research is qualitative and the data were collected through individual interviews with seven teachers, each representing a series from 1 to 7. The authors reported that teachers' understanding of this condition was limited, making it necessary to improve these professionals in order to develop better support and teaching strategies for students with ADHD.

Moore et al. (2017) focused on the experiences and practices of educators on how to work with inattentive, impulsive and hyperactive children. To this end, 42 early childhood education professionals participated in this British study, through focus groups or individual interviews that explored: (1) the experiences of managing students with ADHD in the classroom and (2) factors that helped and hindered them in this effort. The authors identified the need for further research on the implementation of evidence-based school interventions for ADHD, and the importance of considering the experiences of these students to devise the best teaching strategies to be implemented in the classroom.

4.2.3. Exclusive/inclusive education and ADHD



In the seventh and last work of this group, Malmqvist and Nilholm (2016) addressed the increasing increase in exclusive educational classes to specifically serve children with ADHD in Sweden, and how this fact is contrary to the notion of social inclusion and is in conflict with Swedish school law. To this end, a questionnaire was sent to all 290 Swedish municipalities about the education of students with ADHD, and obtaining a response rate of 76%, it was identified that in 40 municipalities there are classes specifically planned for students with this disorder. Therefore, the authors found that classes planned exclusively for students with ADHD are not properly evaluated, presenting divergences in the municipalities. They also discuss the permanence of these classes in the light of inclusive education.

Thus, although considered less relevant, the articles in this group have important contributions to the evaluation of learning processes in classrooms, since the works addressed are the result of real experiences and experiences, both of children and adolescents with ADHD and of their educators. That said, even though they do not establish direct correlations with Design, Neuroergonomics and the Theory of Restorative Environments, these articles will be taken into account for the theoretical basis of the thesis under development.

5. FINAL CONSIDERATIONS

From the Systematic Review, an enormous geographical diversity of studies involving children and/or adolescents with ADHD in the educational environment was found: Iran, Spain, Russia, United States, Netherlands, Brazil, Denmark, United Kingdom, South Africa, and Sweden. The systematization and distribution of the articles into two groups allowed a better understanding of the studies found.

It can be seen that even the articles in group A, considered to be of greater relevance, did not address all the elements of the theme sought. The work of this group correlated attention, suggesting interventions of pedagogical and/or technological procedures to assist in the teaching and learning process for children with ADHD.

Regarding the research methods used in this group, we have the following observations: two studies presented an experimental design with pre- and post-test and follow-up with a control group (Mohammadhasani et al., 2018; and Nazer, 2017), one study presented technological techniques and applications to be used and tested by teachers (Barnett, 2017), two studies developed systematic reviews of the literature (Adaskina, 2016; and Harrison et al., 2019), and finally, two studies used neuroscience tools (Garcia-Zapirain et al., 2017; Janssen et al., 2017).



Many digital tools have been used, such as a computer-assisted instruction (CAI) system: *Koosha* (Mohammadhasani et al., 2018); Physiological sensors: the *Tobii XI Light Eye Tracker* and *Leap Motion* (Garcia-Zapirain et al., 2017); And EEG (Electroencephalography) tool for performing *Neurofeedback* (Janssen et al., 2017).

The interventions of this group were generally considered positive and effective to help the behavior and educational process of children with ADHD; And thus, the tools mentioned will be studied and taken into account, later on, for the methodological development of the thesis.

It was also noted that although several studies by this group suggest that the classroom environment should be equitable among students, only two studies directly cited the need to have effective classroom environments as one of the factors that contribute to the successful adaptation of children with ADHD to schooling (Adaskina, 2016; and Harrinson et al., 2019).

On the other hand, the works of group B, even considered as less relevant articles, were taken into account due to their important theoretical contributions to the research.

It was verified in the work of this group, the importance of understanding the experiences and experiences in classrooms of education professionals and students with ADHD, so that Design and Neuroergonomics interventions can be proposed that meet the real needs of this public, help in the restoration of attention, and consequently, in the learning of children and adolescents with this condition.

The methodological procedures and tools used in the research of this group were: observational methods (Souza, 2016); Assessment through knowledge and attitude scales (Greenway and Edwards, 2020); Semi-structured interviews (Wiener and Daniels, 2016; Dwarika and Braude, 2020; and Moore et al., 2017); And questionnaires (Souza, 2016; Mohr-Jensen et al., 2019; and Malmqvist and Nilholm, 2016).

It was also verified, in almost all group B surveys, that professional educators need more training and qualification to better serve children and adolescents with ADHD in the classroom (Wiener and Daniels, 2016; Moore et al., 2017; Dwarika and Braude, 2020; Mohr-Jensen et al., 2019; Souza, 2016).

In short, through the Systematic Review of the Literature, the gap between the relationship between Design, Neuroergonomics and the Theory of Restorative Environments was perceived for the promotion of a built environment of teaching, which collaborates in the learning process of children with this neurobehavioral condition. And in view of this, it can be



proven that there is a lot of room to be explored in this field, highlighting the relevance of this type of research for society.

For the next steps of this study, it is intended to expand the bibliographic search by expanding the filter from "only articles published in the last 5 years (2016 – 2021) focusing on children and adolescents with ADHD", to "articles published in the last 10 years (2011 - 2021) that cover the public of children, adolescents and adults", since no articles were found that correlated the Theory of Restorative Environments to ADHD in children and/or adolescents in the period searched.

REFERENCES

- ABERGO (Associação Brasileira de Ergonomia). *O que é Ergonomia?*. Disponível em: <<http://www.abergo.org.br/>>. Acesso em: 07 de março de 2017.
- ADASKINA, A.A. Adaptation strategies of children with ADHD to the educational process [Elektronnyi resurs]. *Sovremennaiia zarubezhnaia psikhologiya = Journal of Modern Foreign Psychology*, 2016. Vol. 5, no. 3, pp. 35–40. doi:10.17759/jmfp.2016050303.
- ALTMAN, I., WOHLWILL, J. F. (Eds.). *Behavior and the natural environment*. New York and London: Plenum, vol. 6. 1983.
- ARRUDA, M. A., QUERIDO, C. N., BIGAL, M. E., POLANCZYK, G. V. ADHD and Mental Health Status in Brazilian School-Age Children. *Journal of Attention disorders*, SAGE Publications, vol. 19(I), p. 11-17, 2015.
- BINS ELY, V. H. M. Ergonomia + Arquitetura: buscando um melhor desempenho do ambiente físico. In: *Anais do 3º Congresso Internacional de Ergonomia e Usabilidade de Interfaces Humano-Tecnologia: Produtos, Programas, Informação, Ambiente Construído*. Rio de Janeiro: LEUI/PUC-Rio, 2003.
- BRASIL. *Ministério da Educação*. Diretrizes nacionais para a educação especial na educação básica / Secretaria de Educação Especial – MEC; SEESP, 2001. 79 p.
- BÜRDEK, B. E. História, Teoria e Prática do Design de Produtos. Tradução Freddy Van Camp. São Paulo: Edgard Blücher, 2010.
- CARACTERÍSTICAS DE JOVENS E CRIANÇAS COM TDAH. *Neurosaber*, 2016. Disponível em: <<https://institutoneurosaber.com.br/caracteristicas-de-jovens-e-criancas-com-tdah/#>>. Acesso em: 19 de set. de 2020.



- DWARIKA, V., BRAUDE, S. Teachers' experiences of supporting learners with attention-deficit hyperactivity disorder: Lessons for professional development of teachers. *South African Journal of Childhood Education* 10(1), 2020, a843. Doi: 10.4102/sajce.v10i1.843
- GARCIA-ZAPIRAIN, B., DE LA TORRE DÍEZ, I., LÓPEZ-CORONADO, M. Dual System for Enhancing Cognitive Abilities of Children with ADHD Using Leap Motion and eye-Tracking Technologies. *J Med Syst* 41, 111. 2017. doi:10.1007/s10916-017-0757-9.
- GREENWAY, C. W., EDWARDS, A. R. Knowledge and attitudes towards attention-deficit hyperactivity disorder (ADHD): a comparison of teachers and teaching assistants, *Australian Journal of Learning Difficulties*, 25:1, 2020, p.31-49, DOI: 10.1080/19404158.2019.1709875
- HARRISON, J. R., SOARES, D. A., RUDZINSKI, S., JOHNSON, R. Attention Deficit Hyperactivity Disorders and Classroom-Based Interventions: Evidence-Based Status, Effectiveness, and Moderators of Effects in Single-Case Design Research. *Review of Educational Research*. 2019; 89(4):569-611. doi:10.3102/0034654319857038.
- HART BARNETT, J. E. Helping Students with ADHD in the Age of Digital Distraction. *Research, Advocacy, and Practice for Complex and Chronic Conditions*, 36(2), 2017. p.1–7. <https://doi.org/10.14434/pders.v36i2.23913>
- IEA (International Ergonomics Association). *What is ergonomics*. Disponível em: <<http://www.iea.cc/whats/index.html>>. Acesso em março de 2021.
- IIDA, I; BUARQUE, L. *Ergonomia Projeto e Produção*. Edgard Blucher Editora. 3 ed. 2016.
- JANSSEN, T.W.P., BINK, M., WEEDA, W.D., ET AL. Learning curves of theta/beta neurofeedback in children with ADHD. *Eur Child Adolesc Psychiatry*. 2017; 26(5):573-582. doi:10.1007/s00787-016-0920-8.
- KAPLAN, S., KAPLAN, R. *Cognition and Environment: Functioning in an Uncertain World*. New York, NY: Praeger, 1982.
- KORPELA, K. M. Place-identity as a product of environmental self-regulation. *Journal of Environmental psychology*, 1989. v 9(3), 241-256.
- KUHNEN, ARIANE & PUFF, SANDRA. Psicologia ambiental: a percepção de ambientes/espços restauradores nas escolas e em educandos com TDAH. *Revista UNIASSELVI PÓS*. 2014. v 1.



- MALMQVIST, J., NILHOLM, C. The antithesis of inclusion? The emergence and functioning of ADHD special education classes in the Swedish school system. *Emotional and Behavioural Difficulties*, 21:3, 2016. p. 287-300, doi: 10.1080/13632752.2016.1165978
- MOHAMMADHASANI, N., FARDANESH, H., HATAMI, J., MOZAYANI, N., FABIO, R. The pedagogical agent enhances mathematics learning in ADHD students. *Education and Information Technologies*. 2018. 23. 10.1007/s10639-018-9710-x.
- MOHR-JENSEN, C., STEEN-JENSEN, T., BANG-SCHNACK, M., THINGVAD, H. What Do Primary and Secondary School Teachers Know About ADHD in Children? Findings from a Systematic Review and a Representative, Nationwide Sample of Danish Teachers. *J Atten Disord*. 2019. Feb;23(3):206-219. doi: 10.1177/1087054715599206. Epub 2015 Aug 22. PMID: 26297913.
- MOORE D.A., RUSSELL, A.E., ARNELL, S., FORD, T.J. Educators' experiences of managing students with ADHD: a qualitative study. *Child Care Health Dev*. 2017 Jul;43(4):489-498. doi: 10.1111/cch.12448. Epub 2017 Feb 24. PMID: 28233330.
- NAZER, M. Effectiveness of attention-shaping training in reinforcing attention and academic development and self-efficacy for primary school children with attention deficit hyperactive disorder, *European Psychiatry*, V. 41, Supplement, 2017; p. S448-S449. doi: 10.1016/j.eurpsy.2017.01.470.
- OLIVEIRA, R. A.; ALMEIDA, T. F.; SUZART, N. S. Psicologia Ambiental E A Subjetivação Do Espaço Acadêmico: Um Relato De Experiência. In: Seminário Nacional e Seminário Internacional Políticas Públicas, Gestão e Práxis Educacional, Vol. 7, No 7. 2019.
- O QUE É TDAH. *Associação Brasileira do Déficit de Atenção*, 2020. Disponível em: <<https://tdah.org.br/sobre-tdah/o-que-e-tdah/>>. Acesso em: 5 de jul. de 2020.
- PAIVA, M.M.B. *PERCEPÇÃO DE SALAS RESIDENCIAIS POR IDOSOS – uso das técnicas de Seleção Visual, Realidade Virtual e Eletroencefalografia*. Tese (Doutorado em Design) – Centro de Artes, Cultura e Comunicação, Departamento de pós-graduação em Design, Universidade Federal de Pernambuco. Recife, p. 300. 2018.
- PAPANEK, V. *Design for the real world*. Gra-Bretanha: Thames & Hudson, 1995.
- PARASURAMAN, R.; RIZZO, M. Introduction to Neuroergonomics. In: Parasuraman, Raja & Rizzo, Matthew (Ed.). *Neuroergonomics: The Brain at Work*. New York: Oxford University Press, Inc, 2007, p. 3-11.
- SALAMEH, J., BOSSUYT, P. M., MCGRATH, T. A., THOMBS, B. D., HYDE, C. J., MACASKILL P., ET AL. Preferred reporting items for systematic review and meta-analysis



of diagnostic test accuracy studies (PRISMA-DTA): explanation, elaboration, and checklist *BMJ* 2020; 370: m2632 doi: 10.1136/bmj.n.2632

SCHNEIDER, B. *Design – uma introdução: o design no contexto social, cultural e econômico*/ Beat Schneider; tradução Sonali Bertuol, George Bernard Sperber. – São Paulo: Editora Blücher, 2010.

SILVA, A.B.B.; ROCHA, A. O que é Neurofeedback?. *Ana Beatriz Barbosa Silva*, 2021. Disponível em: <<http://draanabeatriz.com.br/portfolio/o-que-e-neurofeedback/>>. Acesso em: 18 de julho de 2021.

SOUZA, M. Transtorno de Déficit de Atenção e Hiperatividade no processo de ensino-aprendizagem no ensino fundamental. *Eventos Pedagógicos*, 7, dez. 2016. Disponível em: <<http://sinop.unemat.br/projetos/revista/index.php/eventos/article/view/2525>>. Acesso em: 12 Mar. 2021.

WIENER, J., DANIELS, L. School Experiences of Adolescents With Attention-Deficit/Hyperactivity Disorder. *J Learn Disabil.* 2016 Nov;49(6):567-581. doi: 10.1177/0022219415576973. Epub 2015 Mar 20. PMID: 25795542.