# Conceptual Model of the Application of the ABA Method in Alzheimer's Treatment Supported by Data Science

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*Abstract* - **Alzheimer's Disease (AD) is characterized as a neurodegenerative disorder that causes gradually progressive cognitive and functional deficits and behavioral changes. Checking for symptoms of cognitive loss and memory loss, behavioral symptoms, functional decline, and cognitive testing remain the cornerstone of clinical diagnosis and treatment of AD patients. In view of the questions raised from the experience of the researchers, as well as the results achieved by the Applied Behavior Analysis (ABA) method in patients with Autism Spectrum Disorder (ASD), and adopting an innovative perspective of the ABA method aimed at the treatment of patients with AD, we envision the possibility of supporting the ABA method with the use of Data Science (DS) techniques to enable analysis and learning based on the information generated in this process, in search of better quality of life and cognitive, speech-language and psychomotor advances in patients with AD, featuring an important interdisciplinary approach.**

***Keywords - Alzheimer's Disease; Applied Behavior Analysis; Data Science; Conceptual Model.***

## I. INTRODUCTION

Alzheimer's Disease is characterized as a neurodegenerative disorder that causes gradually progressive cognitive and functional deficits and behavioral changes [7]. The specialized literature indicates that its most common cognitive symptoms include deficits in short-term memory, executive, visual and spatial dysfunction, difficulty in carrying out daily activities, even total disconnection from reality [9]. Current studies are converging in stating that the verification of symptoms of cognitive loss, the identification of behavioral symptoms and functional decline and the performance of cognitive tests remain as the basis of the clinical diagnosis and treatment of patients with AD [11]. Individuals with Autism Spectrum Disorder (ASD) or with AD have specific deficits in their ability to learn procedural skills that are explained by the loss of their motor coordination. Thus, we can say that an interdisciplinary team that works with the Applied Behavior Analysis (ABA) method will be able to offer specific stimuli to patients with AD, as is already the case with individuals with ASD, whether they are professionals in Psychology, Speech Therapy, Psychomotricity, Physiotherapy, among others. The use of the proposed tests becomes fundamental in the evaluation of the patient with AD and in the validation of the impact of the ABA treatment, using parameters of comparison of the affected cognitive and motor areas. It is not a question of comparing the use of the ABA method with other methods, but of verifying its feasibility and its application in patients with AD, which has not yet been reported in the literature.

Conjugating with the results of the studies of Castillo et al. [7] and Perakslis et al. [11], we believe that there is no universal treatment for AD, but it is possible to adopt an interdisciplinary and preventive intervention, consisting of psychosocial treatments, behavioral therapy and drug treatment. In this sense, we propose the application of the ABA method in the treatment of Alzheimer's Disease, and based on recent studies that indicate a constant growth in research investment that aligns technologies in the area of Data Science applied to the health area, we envision the possibility of aligning the ABA method to data analysis to support and validate the treatment of AD patients.

The general objective of this study is to analyze the potential of the ABA method in the treatment of Alzheimer's Disease with the support of an informational platform based on Data Science (DS) techniques. Specifically, we intend to: a) study the feasibility and effectiveness of the ABA method in patients diagnosed with Alzheimer's Disease, with a view to expanding quality of life and promoting cognitive, speech-language and psychomotor advances and b) developing a prototype composed of a digital platform using data analysis techniques and algorithms linked to the application of the ABA method to support the treatment of AD patients as a proof of concept of the proposal's feasibility.

This article has the following structure: Section 2 presents a review of the literature on the concepts relevant to the research, with emphasis on the Applied Behavior Analysis method and on Alzheimer's Disease. Section 3 addresses the methodological procedures adopted in the study and the results achieved. Finally, the conclusion is presented.

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## II. LITERATURE REVISION

Behavior Analysis is a science that is dedicated to the study of the elements that affect behaviors. The use of the principles of this science to solve socially relevant demands is called Applied Behavior Analysis – ABA [1]. The ABA method can be applied in different contexts such as ASD treatment, education, economics, psychological clinic, sports performance, among others.

Despite being used in several areas, there was a significant growth in the use of ABA in the area of ASD, especially Lovaas [2], who carried out the first study of ABA applied to the treatment of this type of disorder. The method consists of individual and intensive teaching of skills necessary for the individual to acquire independence and better quality of life. Among the skills taught, those that focus on behaviors that interfere in the development and integration of the individual diagnosed with ASD stand out: a) social behaviors, such as eye contact and functional communication; b) academic behaviors, as prerequisites for reading, writing and mathematics; c) activities of daily living, such as personal hygiene; d) reduction of negative behaviors, such as aggression, stereotypies, self-injury, verbal aggression and escapes.

The literature indicates improvement in the development of participants after undergoing the ABA method, especially when faced with other types of non-intensive therapies or not anchored in Behavior Analysis, especially when the intervention was performed early [3][4][5][ 6]. Based on these studies, which reinforce the success of the ABA method in the treatment of patients with ASD and, as in the studies carried out with patients with AD [7][8], we adopted part of the methodology presented in this study, namely, the of tests in the areas of Speech Therapy, Psychology, Psychomotricity and Physiotherapy.

Castillo et al. [7] exposed a group of AD patients to psychosocial treatment, aimed at individuals with mild and moderate dementia. The treatment included physical activities, sound identifications, childhood explorations, names, foods, current discussions, identification of faces/scenes, word associations, increased creativity, categorization of objects, development of senses, among others. The results obtained were "improvement in orientation, a better understanding and adaptation of their environment, potentially leading to an increase in the feeling and perception of control, self-efficacy and self-esteem", directly impacting the quality of life of patients and their families [7][9].

Giving an innovative perspective to the use of the ABA method in the treatment of AD, we propose to reconcile it with techniques from the DS area to support the treatment of patients through data analysis and the learning generated based on the information obtained in this process, in search of better quality of life and cognitive, speech-language and psychomotor advances, thus justifying other methodological aspects of the study.

Recent literature points out that medical treatments bring together cutting-edge technology, such as systems for remote surgery, exoskeletons or wearables for the elderly to be monitored remotely, for example. IoT, Big Data, AI, nanotechnology and robotics, for example, are available to health professionals for hospital care, diagnosis, staging and monitoring of treatments. The reason for applying DS in medicine is to obtain improved services through the use of data and information analysis. These services are classified in two aspects: the first is the diagnosis and prognosis of the disease, and the second is its treatment and definitive cure [10].

The volume of relevant data on AD generated by the tests that will be applied will generate the need for DS techniques to deal with the informational complexity of these environments. Data Science can provide insight and pattern detection and/or insights for possible decision making. Constant progress in the development of predictive modeling and analysis, digital sensors, advanced monitoring techniques and their analytical capabilities are prepared to allow the real-time study of patients and caregivers in a continuous way in all stages of the disease [11]. A new perspective is needed to manage and process this information, while organizing these resources into new results.

In another study, Krumholz [12] highlights how Data Science techniques and data analysis in Big Data scenarios can contribute to the generation of new knowledge essential for predictions and improve the performance of health treatments. Furthermore, the author points out that the use of Data Science techniques can significantly improve the power of observation for treatments in the health area, precisely because of the amount of data obtained and the use of these data to obtain new knowledge and define patterns that are not found by humans.

## III. METHODOLOGY

Considering that this is a feasibility study, we started with the Systematic Literature Review (SLR) in search of information about the scope of the study, in order to synthesize the production of knowledge about Alzheimer's Disease, the application of the ABA method, the use of Data Science in the health area and, in particular, in the treatment of AD. By retrieving the results of the research already carried out on these subjects, we find:

- Case studies and applications of the ABA method, to establish possible relationships between its application in patients with ASD and patients diagnosed with AD in terms of cognitive gains;
- Case studies and applications of tests and scales in patients with AD in the areas of Psychology, Speech Therapy, Physiotherapy and Psychomotricity, to establish possible relationships between their application, cognitive gains and improvement in quality of life;
- Case studies, techniques, applications and DS models applied in learning and improving the treatment of AD based on massive environments of data generated by the treatment and the tests mentioned in the previous activities;

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- Case studies and identification of methodologies and technologies for modeling, merging, mining, management and data analysis, applied to the representation and processing in digital informational environments of data analysis systems, based on information from the capture of AD treatment with the application of the ABA method.

The SLR followed the precepts described by Higgins and Green [13] and included works published in the period from 2000 to 2021, with regard to works on ABA and DA and in the period from 2010 to 2021, with regard to works on SD and national and international journals were searched.

We used the Multiple Case Study (MCE) research method, as proposed by Yin [14]. The method is characterized by simultaneously studying more than one particular case representing a set of comparable or equivalent cases. It is an "empirical investigation that investigates a contemporary phenomenon within its real-life context, especially regarding the boundaries between the phenomenon and the context that are not clearly defined", seeking to know the how and why of a specific situation [ 14].

The MCE is composed of patients from the Religare Clinic – Rehab Center. The Religare Clinic is located in the city of Santo André, metropolitan region of the State of São Paulo, Brazil. Diagnosed with mild or moderate AD, identified and chosen intentionally, for Alzheimer's Disease submitted to the ABA method, patients will be submitted to the application of tests and scales in the areas of Physiotherapy, Psychomotricity, Psychology and Speech Therapy, to assess their cognitive performance and improvements in quality of life and to validate the ABA method in the treatment of these patients. The tests will be applied in a future stage of the research. In MCE, data analysis can be performed using various techniques and tools, such as the use of computer programs, tabulations, categorization, tests and combination of evidence and data collected in SLR. At this stage of the research, we will make use of the following strategies: analysis in the light of SLR; analysis based on the results achieved with the tests and scales applied to patients; analysis based on the information provided by the metadata standard implemented to represent AD treatment data. The use of disruptive computing technologies using Data Science resources will expand the possibilities of treatment through the digitization and automation of processes that increase the ability to exponentiate the analysis of results.

It is proposed to use massive data analysis techniques generated from the diagnosis history, application of the ABA method and tests in related areas to support treatment evaluation plans and improvements in the adequacy of the ABA method in the treatment of AD.

Figure 1 presents the conceptual model of the proposal that results in the development of the prototype that will be validated through a proof of concept of the presented methodology.

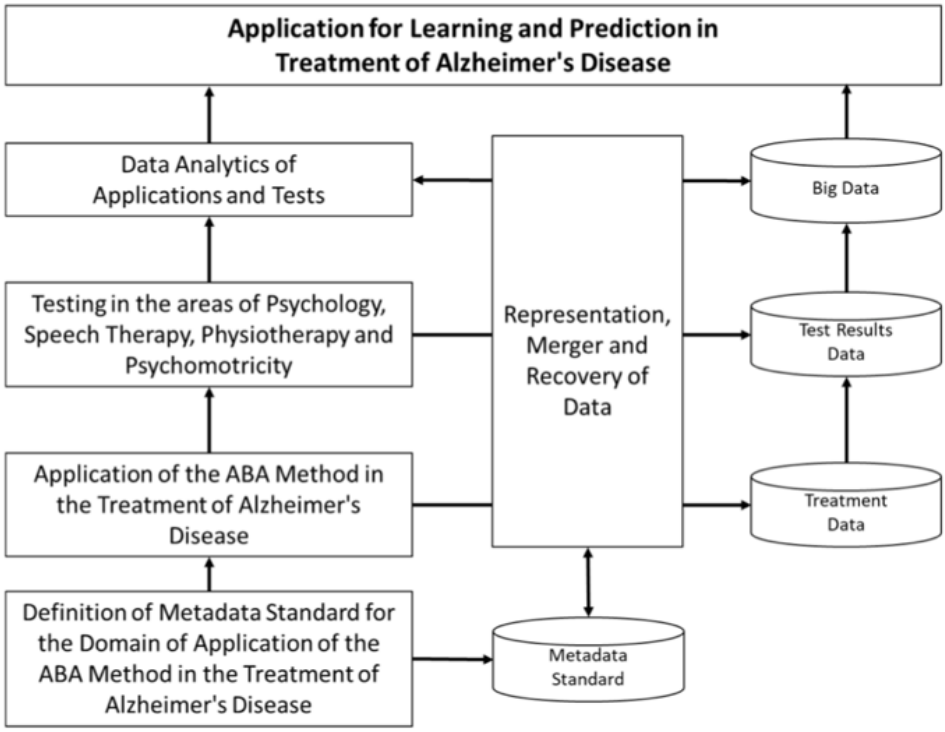


Figure 1: Conceptual Model of Application of the ABA Method in Alzheimer's Treatment Supported by Data Science

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The main purpose of the conceptual model is to capture information requirements from a research point of view. As an important instrument used to represent the prototype to be developed, the construction of a Conceptual Model should not be limited only to the need to represent the prototype, but rather to develop global views of the entire research process. This can be seen in Table I that specifies the components that represents the Conceptual Model.

TABLE I. CONCEPTUAL MODEL COMPONENTS

| Category | Component | Especification |
|---|---|---|
| Data Layer | Metadata Standard | Standardized data scheme of informational elements describing the characteristics of AD and treatment methods. |
| Data Layer | Treatment Data | Data extracted from the treatment of AD. |
| Data Layer | Test Result Data | Results obtained through tests applied after treatment |
| Data Layer | Big Data | Database formed by several information sources obtained from diagnosis, treatment and tests. |
| Process Layer | Definition of Metadata Standard | Specification of the conceptual data schema of the proposed model. |
| Process Layer | Application | Treatment of patients with AD using the ABA Method. |
| Process Layer | Testing | Application of tests in patients treated with the ABA Method. |

To support the digital informational application to be developed to validate this proposal, a metadata standard is defined that simplifies and standardizes the data that will be generated in the application phases of the ABA method in the treatment of AD and in the application of the tests. From this metadata standard, a database with Big Data characteristics will be built from the generation of data in each subsequent phase, until the moment of analysis of the generated data and transformation into information for the application of learning and prediction that improve the AD treatment process. It is expected that with the implementation of this model, there will be an improvement in the treatment of AD through the application of the ABA method supported by indicators and knowledge generated by applications in the area of Data Science based on Big Data environments.

## IV. CONCLUSION

The partial results indicate that the technological structure applied in the AD treatment process will allow innovation in the treatment methodology through the ABA method applied in AD and innovation in the use of disruptive computational technologies in the process of evaluation, testing and learning of AD treatment. The feasibility study of the techniques and activities of the ABA method to be adopted in the treatment of patients with AD is under development and a protocol for the application of tests and scales in the areas of Psychology, Speech Therapy, Psychomotricity and Physiotherapy able to validate the ABA method in the treatment of patients with AD.

In the end, it is expected to develop a prototype of DS application based on the information generated by the tests for learning and predicting the treatment of AD with ABA method resources, to subsidize the proof of concept that supports this proposal.

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