



Transdisciplinarity and Interdisciplinarity in Education



Fernanda Tebexreni Orsati
Amanda Douat Cardoso
Tais Morosi Lara Campos
Elizeu Coutinho de Macedo

Graduate Program
in Developmental Disorders



This book presents the discussion of essential topics within transdisciplinarity and interdisciplinarity in Education, adding knowledge from different regions of Brazil and from different places in the world. In the chapters prepared by researchers in the fields of education, psychology, medicine, physiotherapy, computer science, among others, discussions are presented covering theoretical and practical aspects underlying the educational processes. In addition, the texts reflect discussions by researchers from the Graduate Program in Developmental Disorders at Mackenzie Presbyterian University, as well as specialists from foreign and Brazilian universities. The book presents contents that should inspire the search for interdisciplinary solutions in facing the different challenges in Brazilian education.

This book was produced with financial funding from the Academic Excellence Program (Proex), Process number 1133/2019, from the Coordination for the Improvement of Higher Education Personnel - Brazil (CAPES).

The research presented in this book were supported by: Higher Education Personnel Improvement Coordination (CAPES), Research Support Foundation of the State of São Paulo (FAPESP), National Development Council Scientific and Technological Development (CNPq) and Mackenzie Research Fund (MackPesquisa).



Transdisciplinarity and Interdisciplinarity in Education

Editors

Fernanda Tebexreni Orsati

Amanda Douat Cardoso

Tais Morosi Lara Campos

Elizeu Coutinho de Macedo

**Graduate Program
in Developmental Disorders**



CIP-BRASIL. CATALOGAÇÃO NA PUBLICAÇÃO
SINDICATO NACIONAL DOS EDITORES DE LIVROS, RJ

T696

Transdisciplinarity and interdisciplinarity in education [recurso eletrônico] : graduate program in developmental disorders / organização Fernanda Tebexreni Orsati ... [et al.] ; [tradução Fernanda Tebexreni Orsati ... [et al.]] - 1. ed. - São Paulo : Edicon, 2020.
recurso digital

Tradução de : Transdisciplinariedade e interdisciplinariedade na educação :
programa de pós graduação em distúrbios do desenvolvimento

Formato: epdf

Requisitos do sistema: adobe acrobat reader

Modo de acesso: world wide web

Inclui bibliografia

Índice remissivo

ISBN 978-65-5934-002-6 (recurso eletrônico)

1. Abordagem interdisciplinar do conhecimento na educação. 2. Teoria e Prática Pedagógica. 3. Educação - Finalidades e objetivos. 4. Livros eletrônicos. I. Orsati, Fernanda Tebexreni.

20-67575

CDD: 370.1

CDU: 37.01

Camila Donis Hartmann - Bibliotecária - CRB-7/6472

13/11/2020 13/11/2020

The reproduction, whether partial or complete, of the journal is prohibited, in any printing means, in identical, summarized or modified form, in Portuguese or in any other language, without due authorization by the editor. The violation of copyright (Law nº 9,610/98) is a crime established by Article 184 of the Criminal Code.



PROGRAMA DE PÓS-GRADUAÇÃO

EM DISTÚRBIOS DO DESENVOLVIMENTO

R. da Consolação, 930 - Consolação, São Paulo - SP, 01302-907

E-mail: disturbios.pos@mackenzie.br"

EDITORIAL BOARD

PASCALE ENGEL DE ABREU

Associate professor of multilingual cognitive development at the ECCS Research Unit. Specialist in cognitive development in her doctorate from York University (United Kingdom) and Master in developmental psychology from Durham University (United Kingdom) and Louis Pasteur University (France). She has postdoctoral research experience at Oxford University (United Kingdom), Princeton University (USA) and York University (Canada). Child psychologist registered in Luxembourg.

NATÁLIA MARTINS DIAS

Psychologist at São Francisco University. Master and PhD, with post-doctorate, in Developmental Disorders at Mackenzie Presbyterian University. Professor in the Department of Psychology - Undergraduate and Graduate Studies stricto sensu at the Federal University of Santa Catarina - UFSC, Florianópolis, SC. Coordinator of the Neuropsychology and Child Development Research Group - GINDI (www.facebook.com/gindi2019) and of the Cognitive and School Neuropsychology Laboratory - LANCE - UFSC (<https://lance.paginas.ufsc.br/> / <https://www.facebook.com/lance.ufsc/>). Member of the current management (biennium 2019-2021) of the board of the Brazilian Society of Neuropsychology - SBNp. CNPq Productivity Scholarship.

MARIA DE JESUS GONÇALVES

Speech therapist at the Pontifical Catholic University of São Paulo (1984), Master in Linguistics at the State University of Campinas (1989) and PhD in Experimental Psychology at the University of São Paulo (1999). Professor at the Federal University of Rio Grande do Norte, in the Speech Therapy Course, since 2010. Academic Advisor at the Health Sciences Center at the Federal University of Rio Grande do Norte. Teaching experience, for 30 years, in speech therapy courses in the area of language and coordination of the undergraduate course from 2001 to 2007 and from 2011 to 2014. She developed Clinical Activity as a speech therapist in the area of Alternative and Supplementary Language and Communication, working mainly in pictures of speech and language changes due to neurological damage such as strokes, traumatic brain injuries, amyotrophic lateral sclerosis, cerebral palsy, among others.

TATIANA PONTRELLI MECCA

Psychologist, Ph.D. in Developmental Disorders from Mackenzie Presbyterian University. Professor of the Graduate School in Psychoeducation and Neuroscience in Education and Learning at Mackenzie Presbyterian University. Professor of the Mental Health Department at Medical Science University at Santa Casa of São Paulo.

EDITORS

FERNANDA TEBEXRENI ORSATI

Psychologist, PhD in Special and Inclusive Education from Syracuse University. She works as a clinical psychologist, consultant in psychoeducational and inclusive supports, and an entrepreneur. She recently launched an alternative communication application, is a professor in the Post-Graduate course in Psychoeducation and post-doctoral candidate in Developmental Disorders, both from Mackenzie Presbyterian University

AMANDA DOUAT CARDOSO

Psychologist (Mackenzie Presbyterian University), Master's student in the Postgraduate Program in Developmental Disorders (Mackenzie Presbyterian University), with a grant from the São Paulo Foundation for Research Support (FAPESP). Researcher at the Cognitive and Social Neuroscience Laboratory.

TAIS MOROSI LARA CAMPOS

Psychology undergraduate, intern and researcher at the Cognitive and Social Neuroscience Laboratory at Mackenzie Presbyterian University.

ELIZEU COUTINHO DE MACEDO

Psychologist, Master and PhD in Experimental Psychology (University of São Paulo). Adjunct Professor of the Postgraduate Program in Developmental Disorders at Mackenzie Presbyterian University. Member of the Paulista Academy of Psychology (chair 32). Research Productivity Scholarship 2 - CNPq. Researcher at the Cognitive and Social Neuroscience Laboratory.

ACKNOWLEDGMENTS

This book was produced with financial funding from the Academic Excellence Program (Proex), Process number 1133/2019, from the Coordination for the Improvement of Higher Education Personnel - Brazil (CAPES)."

The research presented in the chapters of this book was supported by different funding agencies such as: Coordination for the Improvement of Higher Education Personnel (CAPES), São Paulo State Research Support Foundation (FAPESP), National Council for Scientific Technological Development (CNPq) and Mackenzie Research Fund (MackPesquisa) from Mackenzie Presbyterian University.

SUMMARY

Preface.....	15
Book Presentation	17
CHAPTER 1	
Interdisciplinarity in education: theoretical perspectives and example of the postgraduate program in developmental disorders	23
CHAPTER 2	
Culturally relevant pedagogy: An interdisciplinary approach to developing cultural fluency about the Sateré-Mawé.....	37
CHAPTER 3	
Inter-Institutional Doctorate (DINTER) in Development Disorders for teacher training and its contribution for public policy in Maceió, Alagoas	51
CHAPTER 4	
Challenge based learning as a transformational method of the educational process	65
CHAPTER 5	
Educational digital tools to assist learning of people with intellectual disability	87
CHAPTER 6	
Use of functional near-infrared spectroscopy as an auxiliary tool for the evaluation of working memory in scholars.....	111

CHAPTER 7	
A model for evaluation of students' neurobehavioral complaints in school context.....	135
CHAPTER 8	
Contributions of science to the study of language and reading development	153
CHAPTER 9	
Non negotiables of inclusive education	173
CHAPTER 10	
Students with special educational needs: Role of health in the interface with education	193
CHAPTER 11	
Autism in Brazil: From the early diagnostic related factors to the guarantee of rights.....	213
CHAPTER 12	
The contribution of Speech Therapy in programs to support students with difficulties in the learning process at school	231
CHAPTER 13	
<u>Development of a resilience program for adolescents in a school setting .</u>	245
CHAPTER 14	
Development of a resilience program for adolescents in a school setting .	259
Collaborating authors	277
Remissive Index	289

PREFACE

In 2019, we hosted the Interdisciplinarity in Education International Symposium as an activity of the Graduate Program in Developmental Disabilities (PPG-DD the acronym in Portuguese) from Mackenzie Presbyterian University. In fact, PPG-DD has in its strategic planning the goal to evidence and amplify interdisciplinary and internationalization actions with the exchange of students and participation in multicentric studies with international impact.

The initial idea of hosting the Symposium was to gather knowledge, expose project, initiate discussions and form partnerships so that different experiences in Education are spread and the challenges within each specialty can be seen from a different angle, the Interdisciplinarity.

Therefore, the event had the goal of presenting and discussing different theoretical and practical effective educational strategies based upon well succeeded experiences and created a space of discussion and sharing of these practices from an interdisciplinary perspective, from experiences, research and scientific evidence.

The symposium gathered researchers and professionals dedicated to understanding and promoting effective educational practices in different educational contexts, from Early Education to Higher Education. It was targeted to whom was interested in educational practices that promote an egalitarian and just society. The symposium counted with the presence of students, researchers, educators, educational and policy

administrators, clinicians, family members, people with disabilities and specific educational needs in Brazil and internationally, from the USA and Europe.

In the present book, as well as in the event, we raised discussions on essential themes within Transdisciplinarity and Interdisciplinarity in Education, gathering knowledge from various regions of Brazil and different locations in the world. Besides, we bring these next 14 chapters, discussions bringing theoretic and practical aspects in an interdisciplinary comprehension of strategies and educational processes, accessible to diverse audience. We hope that the content of this book inspires you to look for new ways in which together we can create different aspects to education and look for interdisciplinary solutions in facing the obstacles.

BOOK PRESENTATION

In more than 20 years of existence, the Graduate Program in Developmental Disabilities (PPG-DD the acronym in Portuguese), has contributed to the knowledge production and the training of human resource in an interdisciplinary approach for development and its disorders. Recognized as program of excellence by the Improvement Coordination of Higher Education, in Portuguese acronym Capes, it is a strong program in the interdisciplinary area of Education. Because of its excellence, Capes recognized PPG-DD as part of the Excellence Programs – PROEX, offering a series of measures that have allowed for the advancement of research, teaching and extension in the program. The present book is one of the products supported by PROEX – Capes process number 1133/2019, which financed this free and bilingual ebook. Additionally, some of the research presented in the different chapters are funded and supported by other agencies besides Capes, including State of São Paulo Research Support Fund (FAPESP in Portuguese), National Council for the Scientific and Technological Development (CNPq), and Mackenzie Fund for Research (MackPesquisa) from Mackenzie Presbyterian University.

Offering the complete book on an electronic format, for free and in both versions, Portuguese and English, we target both our Brazilian population including educators, psychoeducators, psychologists, speech pathologists, and other professionals connected to schools, as well as an international audience allowing our research and practice to be broadly spread. The book itself was originated in the Interdisciplinarity in Edu-

cation International Symposium, where there were the participation of Brazilian and international students, professors, and researchers, coming from USA and in Europe. This symposium brought such a relevant theme to life, interdisciplinarity in education, allowing for profound reflections and exchanges between participants.

Interaction and connections between disciplines is an extremely valuable theme in the current context, particularly for the promotion of practical-scientific efficient and applicable knowledge. Several professions, research projects and areas of study are occupied trying to understand and promote their intersection with education, which is so basic and underlies all other areas of study due to the aspect of teaching itself.

In the current context of our education, an interdisciplinary approach becomes even more relevant. Relevant because it needs to be active and search for partnerships and actions in different contexts with different populations; it needs to borrow from and lend to technology promoting a dynamic interface accessible for more and more learners; it needs to be based in assessment models that in actuality translate the learning processes of our students; and finally, it needs to be occupied in contributing with strategies and practices that target in equity for access and learning for all students.

In the current reality, now in the first semester of 2020, besides all the habitual challenges that are part of developing efficient practices aligned with quality and equity of education, we are also dealing with a newly reconfigured society due to the need of isolation for diminishing the impact of COVID-19. We can see an even larger relevance in this

new context of interdisciplinary studies and strategies in these changing times. With the university and school classes suspended or adapted to be taught using virtual systems, technology became essential in education. The attention to mental health and cognitive processes while we are confined, as well as the reconfiguration of social relationships and the importance of listening to personal repercussions, are even bigger. The individual experiences are merged with the collective ones and all the educational practices need to be strategized with this perspective in mind.

We will start reading this book thinking about the possibilities of interdisciplinarity in action. Chapter 1 “Interdisciplinarity in education: Theoretical perspectives and the example of the Postgraduate Program in Developmental Disorders” presents the concept of interdisciplinarity, the relevance of this work in the educational context and research projects, giving the practical example of the PPG-DD and its practice-scientific projects. In the second chapter “Culturally relevant pedagogy: An interdisciplinary approach to developing cultural fluency about the Sateré-Mawé”, the authors reveal that the interdisciplinary practices must have a role not just in academic success, but also the development of the cultural competence and political-cultural consciousness, that comes with a proposal of a critical and relevant curricular inclusion of the indigenous people, respecting and valuing their culture in various disciplines. Lastly in this section of the book, the Chapter 3 describes the consolidated interdisciplinary project in “Inter-Institutional Doctorate (DINTER) in Developmental Disorders for teacher training and its contribution for

public policy in Maceió, Alagoas" in which the authors tell the trajectory of this partnership in the promotion of creating new graduate projects in other Brazilian regions offering different perspectives about this work from the promoting institution and the students themselves.

The second group of themes that present several intersections intersection with education is technology. The Chapter 4 "Challenge Based Learning as a Transformational Method of the Educational Process" talks about the element of digital transformation in education, highlighting the use of this approach in technology as an interdisciplinary resource, essential to the construction of knowledge that is relevant to the student. The next chapter, "Educational digital tools to assist learning of people with intellectual disability", describes how the different specialists can use digital games in the learning process of children with intellectual disabilities in two different disciplines, as well as what are the prerequisites for the children, and in the end provides examples of games to be used. Chapter 6 "Use of functional near-infrared spectroscopy as an auxiliary tool for the evaluation of working memory in scholars" employs technology of functional magnetic resonance imaging to understand the relationship between the efficiency of the working memory in learning processes in improving expressive and receptive vocabulary.

This next section of the book focuses the importance of an interdisciplinary assessment in education. In Chapter 7 "A model for evaluation of students' neurobehavioral complaints in school context", the authors emphasize the use of informatized systems that keeps developmental data of students with different disabilities and help educational pro-

fessionals to make decisions on interventions aligned with family and the health system. The other chapter of this section “Contributions of science to the study of language and reading development”, describes different components, particularly the role of automatic rapid naming as one of the main predictors in the detection of reading problems, showing how assessment can support prevention of delays and promote essential abilities in learning.

In this last section of the book, the authors contribute with educational practices and strategies. We start with “Non negotiables of inclusive education” in Chapter 9. In this chapter, the authors delineate essential elements in different disciplines so that a school and classroom can legitimately be considered inclusive and teach all students with equity. Chapter 10 “Students with special educational needs: Role of health in the interface with education” defends, as the authors themselves describe “An interdisciplinary and integrated approach between mental health professionals and educators can lead to comprehensive and targeted treatments that encompass both academic and mental health interventions, contributing to the improvement of educational and health-related outcomes in vulnerable children and youth.”. Following, Chapter 11 “Autism in Brazil: From the early diagnostic related factors to the guarantee of rights” focuses on the theme of autism providing the reader an extended vision of the history of this condition, the diagnosis in the country and how the access to education is anticipated but not yet guaranteed in its totality. Next, Chapter 12 exemplifies interdisciplinarity and explains in “The contribution of Speech Therapy in programs

to support students with difficulties in the learning process at school” explains the importance of the clinical work and the role of educational speech pathologists to promote the development of students that have learning difficulties or disorders. Chapter 13 titled “Environmental enrichment as an intervention in an animal model to improve cognition” presents the study of the memory formation in animals and the importance of an enriched environment for the processes of consolidation and recall of memories, and as a consequence, essential for learning during the schooling period. Lastly, Chapter 14 “Development of a resilience program for adolescents in a school setting” describes the basic and effective elements described in the literature as promoting resilience and finish proposing a structure to be established in classrooms acting in preventive and interventive ways in learning and other emotional and behavioral processes.

We hope the present book enriches your work and studies with theoretical and practical interdisciplinary proposals to be put into action.

ALESSANDRA GOTUZO SEABRA
FERNANDA TEBEXRENI ORSATI
ELIZEU COUTINHO DE MACEDO

CHAPTER 1

Interdisciplinarity in education: theoretical perspectives and the example of the postgraduate program in developmental disorders

Maria Eloisa Famá D'Ántino

Alessandra Gotuzzo Seabra

"Everything that is positivity in us, it is due to some limitation. Furthermore, this limited being, this one-handed being that is what it called destiny, life. What we lack and oppress us is what constitutes and sustains us. Thus, let us accept destiny".

(Ortega & Gasset, 2004, p.141)

The understanding of the concept of interdisciplinarity has been currently constituted as the study object for many researchers around the world. The sociologist Louis Wirtz was the first scholar to use the term, in 1937 (Mateus, 2015). However, it was from the 1960s, with George Gusdorf, that the debate (and clash) about interdisciplinarity in the sciences began. In 1961, Gusdorf presented to United Nations Educational, Scientific and Cultural Organization (UNESCO) an interdisciplinary Project for the Humanities, where he expressed his concern with a group of researchers, who were inclined to create a synthesis of knowledge,

aiming to culminate in an interdisciplinary mentality for coping with the techniques progress and the emergency of the multiple subjects that could expand the number of specializations. The interdisciplinary project in the sciences had a first phase of a humanistic character, concerning its definition and explanation. In the 1980s, it changed to a phase of scientific discussion, especially in the humanities.

Intending to break disciplinary barriers imposed by the positivism of the 19th century, from the idea of building globalizing knowledge, the interdisciplinarity arrives in Brazil initially with studies of Gusdorf's work. Later, it evolved by the hands of Hilton Japiassu who, in 1976, launched the book *Interdisciplinarity and pathology of knowledge*, which, even today, has been dealing with interdisciplinary ideas in the epistemological field.

Gusdorf, who coined the term pathology of knowledge, was the one who influenced Japiassu's thinking, having even prefaced his work. In this preface, Gusdorf (1976) refers to the serious disease that affects the world and the cure for this disease, which would be interdisciplinarity, the cure for what he called the pathology of knowledge.

In Brazil, concern about interdisciplinarity was expanded so that it could be observed in several texts, especially in the education area, from the first half of the 1970s. The discussion on the interdisciplinarity foundations, according to Gudorf, can be attributed to philosophy.

Interdisciplinary research, from the perspective of Japiassu (2006), takes place at the border points among different sciences, can be developed by either one or a group of researchers, and can generate the

production, by merging, of a new interdisciplinary discipline, as in case of biophysics, for example. Interdisciplinary research seeks not only to promote the convergence and complementarity of various disciplines to achieve a common objective but also to use it to try to obtain a synthesis among the methods, the formulated laws and the proposed applications used by the different disciplines.

Ivani Fazenda, was also influenced by Gusdorf's studies in the field of education, published, in 1979, *Integration and interdisciplinarity in Brazilian education: effectiveness or ideology* (known in Brazil as *Integração e interdisciplinaridade no ensino brasileiro: efetividade ou ideologia*). In that work, she sought the basis for the establishment of a concept for interdisciplinarity. She presented it as a new attitude that can understand and transform the world from the restitution of the lost unity of knowledge. The same author warned us that the very repercussion of the word 'interdisciplinarity', used indiscriminately as fashionable, announced the need for a new paradigm construction of science, knowledge and the elaboration of a new education, school and life project (Fazenda, 1979).

Paviani and Botomé (1993, p. 11) state "it is not possible to escape from subjects scientific prison jumping their walls, but removing their false territorial limits whether of epistemological, methodological and linguistic nature or simple conventions of academic and bureaucratic practice ". At the same time, Nissan warns us," it will be unlikely that, even under at more propitious circumstances, an interdisciplinary researcher totally masters a broader area in knowledge than the experts on the subject" (Nissan, 1997, p. 208).

In Japiassu (1976) we find the impasse consideration when he alerts on the need of going back to past, more specifically to Greek antiquity, to study the interdisciplinarity concept, given that in that culture the knowledge was treated in its totality and in the knowledge interconnections, not conceiving the knowledge isolated on its particularities. In an article entitled *The Interdisciplinary Spirit*, Japiassu (2006) refers to Pascal's writings, therefore, to the 17th century, in which he said: *I consider impossible to know at parts if I do not know the whole and if I do not know particularly at parts*, referring to the idea of both non-fragmentation and the apprehension of the totality when one wants to know an object. What I meant is that when seeking to dominate an object it is not possible to rely on the fragmented knowledge, nor either in the apprehension of the totality, since the knowledge must take place in dialectical movement between the local and global level as well as the feedback from the global to the particular. In one way or another, these authors seek to meet, through their studies on interdisciplinarity, the hierarchical levels of the meetings and exchanges among subjects and its applicability in a real socio-historical context.

Scientific and technological advancements that we have seen in many different fields encourage us, even more, to search tangencies among related areas to turn the fragmented knowledge in an amalgamated knowledge that is likely to become more effective and humanistic to care for people with developmental disorders. In that sense, we bring Gusdorf again, in 1976 (and so current, still!) states that the "... blind run without paying attention to the human landscape surrounding it, with-

out dreaming with what was left behind, to better follow the frenetic conquest spirit, which drags them to a terrible future" has been constituted the motto in our modern society (Gusdorf, 1976, p.23).

The importance of interdisciplinary performance has been recognized by the Coordination for Improvement of Personal Higher Education (known in Brazil as Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - CAPES), a foundation of the Ministry of Education (MEC), which plays a fundamental role in the expansion and consolidation of the research graduate programs (master and doctorate).

According to the CAPES Interdisciplinary Area Report (2019), interdisciplinarity is a "*form of knowledge production that implies theoretical and methodological exchanges, generation of new concepts and methodologies and increasing degrees of intersubjectivity, aiming to meet the multiple nature of complex phenomena*" (p. 9). Interdisciplinarity is considered a privileged space for the institution's performance in relation to the national graduate system. This is because it has a transversal nature, exceeds the limits of isolated disciplines, enables the generation of new concepts, theories and methods, and establishes connections among different forms and logics of knowledge production.

Some characteristics of interdisciplinary performance, in which there is a convergence of two or more areas of knowledge, not belonging to the same class, are the possibility of contributing to the science and technology frontiers advancement, the transfer of methods from one area to another, generating new knowledge, and the emergence of a differentiated professional, with a new profile, different from the ex-

isting disciplinary professionals. They have training that enables understanding and proposing solutions to the increasingly complex problems that arise in modern societies (CAPES, 2019). In fact, according to Cesco et al. (2014, p. 57), *"in social and techno-scientific issues (...), there are certainly political, technical, cultural and interrelational dimensions that will only be perceived and answered when we overcome disciplinary barriers"*.

CAPES' Interdisciplinary area has expanded rapidly since its beginning in 1999, following a proposal by Professor Luiz Bevilacqua. That year, there were 46 masters and doctoral courses, addressed to study complex phenomena that required solutions that would overcome disciplinary barriers. There was a clear need both for new modes of knowledge production and for the training of human resources qualified to deal with phenomena located on disciplinary boundaries. In 2006, with 189 courses, four thematic chambers were created, within the Interdisciplinary area, with their own coordination, namely: Environment & Agrarian; Social & Humanities; Engineering, Technology & Management; Health & Biological. In addition, other areas were created, derived from interdisciplinary proposals, including Teaching; Biotechnology; Material and Environmental Sciences.

In 2019, the Interdisciplinary area already had 368 Programs. The area demonstrates a very evident concern related to their impact on society. It is expected that the programs allocated in it promote an interdisciplinary attitude in the three areas involved in a university, namely, teaching, research and extension, with a strong social insertion of its scientific and technological production.

The interdisciplinary conception of the Postgraduate Program in Developmental Disorders emerged in 1992, with such a prospect of advancing beyond disciplinary boundaries, it searches to deal with fragmented knowledge in order to create new knowledge, as highlighted, for example, by Gusdorf.. This nomenclature was adopted based on the recommendations of the Diagnostic and Statistical Manual of Mental Disorders-DSM III (APA, 1980) at the time. An academic trajectory markedly turned for the understanding of questions related to Developmental Disorders and, more particularly, for the genetic or acquired disabilities working on the systematization of studies and researches of socio-educational nature, mainly to those focused on the family-school and society triad. The research developed so far has centered its concerns in theoretical and methodological aspects that underlie the historical conceptions to developmental disorders conceptualizations. In addition, it explores identification and diagnosis of disabilities and the critical analysis of organization and care offered and provided to whom is affected by it.

Special attention has also been given to questions related to the processes and mechanisms in exclusion, segregation, institutionalization and social inclusion, which already indicate a need to seek dialogues among philosophy, sociology, pedagogy, neurology, genetics, psychology, physiotherapy, speech therapy, among others. Each area in itself has essential importance in dealing with the referred issues; however, they would know not be enough to understand and deal with such a complex and comprehensive phenomena separately.

Our challenge has been to find points of intersection among disciplinary knowledge areas for a better understanding of the phenomenon that involves subjects with developmental disabilities, seeking the essential guiding principle for the articulation among them. In our view, the investigative spirit that leads to a search for new knowledge should be nurtured through the possibility of dialogue among several disciplinary and complementary fields. The object of our research is the subject in all his human dimension that must be considered and respected in his broadest possibility of being in the world, in the world in relation to others.

Nevertheless, the movement of approximation and intersection of areas for the understanding of such a subject has been generally only tangential with areas or disciplines “lending” to others some concepts or definitions of their own without, however, constituting themselves in researches that can be effectively interdisciplinary. Here are some issues that wonder us: a) what is meant by interdisciplinary research? How (or if) has it been built today? What has been its scope? Besides, if it really has already a theoretical-methodological constitution, how can it be put at the service in research involving the individual with developmental disabilities, given the complexity that accompanies their peculiar constitution? Even if you do not have it here, in this space and time, the claim to respond to a broader and complex set of issues to be answered by us, we will look to accept them as provocations for our reflection process.

In the last twenty years of existence of our Postgraduate Program in Developmental Disorders, we have been able to follow the considerable

advances in the knowledge of the brain, since its anatomical organization, its information processing system, as well as its interaction with the outside world, given with the neuroscience findings. That is, now we can better understand the relationship of the brain with the physical, social and cultural environment. Such advancements made it possible, to a certain extent, that some aspects of the fundamental importance of the “secret box” called the brain could be known, changing, from this knowledge, deterministic conceptions about the brain functioning of some pathological and/or syndromic conditions, as well as some of its causes, consequently focusing on new researches. Such advancements, however, were not sufficiently incorporated and used by knowledge areas as pedagogy and even by special education so that they could carry out researches that could scientifically subsidize its educational practices, altering not only the teaching approach but also taking into consideration its very learning conception underlying to interventionist performance in the educational field turned to this piece of the school population.

One of criticism that has been leveled at the scientific production area is related to what involves developmental disorders. In one hand, it refers to a reductionist perspective, based on closed investigations, primarily, medicine and psychology, which, in the last instance, are not able to cope, *per si*, with all the phenomenon complexity. On the other hand, there is a reduced scientific interest from human and social sciences in dealing with researches in this area, highlighting the need of studies and investigations in eminently interdisciplinary character, for its better description, understanding and interpretation, so that studies and

investigations scientific of developmental disorders should “*expand their disciplinary base beyond psychology and biology, in order to include different social, policies and cultural sciences*”, according to Skrtic (1996, p. 62).

However, the space of studies, reflection and researches and consequently of scientific production in Brazil is still incipient, especially in the search for an interdisciplinary approach to questions that involve new technologies in diagnosis and interventions, whether within the clinical and/or therapeutic scope, or educational of this significant contingent of population.

In this context, the Postgraduate Program in Developmental Disorders (PPG-DD) has played a strategic role in the State of São Paulo and at the national level, for knowledge production and training of human resources linked to developmental disorder/disabilities in educational and health contexts. The program is organized around the area of concentration in “Psychology, education and health” and has three lines of research:

Line 1: Studies of development and its disorders in the clinical, cognitive, behavioral and epidemiological areas: with individual and social implications. Study of the development of children and adolescents with special needs and/or physical and mental disabilities.

Line 2: Developmental neurosciences: an investigation of the basic neural mechanisms that determine or have a role in the establishment of developmental disorders. Conducting studies with animals and humans with observation and data recording of behavioral and molecular phenotype.

Line 3: Policies and forms of care in education, psychology and health: a study of national policies related to people with disabilities, specialized procedures, and public and private care programs.

From an interdisciplinary perspective, the PPG-DD considers that the study of development and its disorders is a great challenge in our society, as it is of great complexity. It demands the knowledge connection, methods and theories of different specific disciplines in an integrated way that allows new, creative and high social impact solutions. Our scientific and technological products are the result of such reflection, often derived from work along with education or health institutions. For example, we have worked with city halls in different municipalities, seeking, in partnership with the various health and education actors, to trace innovative ways of understanding and intervening with neurodevelopmental disabilities.

An example of our program performance is the projects carried out in partnership with municipal governments, such as in Barueri and Embu das Artes. In Barueri, a project was financed by the PROESP, coordinated by the first author of this chapter, which focused on the development of Basic Education, specifically with students with developmental disabilities. The 4-year project integrated teaching, research and extension and resulted in more than 25 works among dissertations and theses (available on the website of our university: <http://tede.mackenzie.br/jspui/browse?type=program&order=ASC&rpp=20&value=Dist%C3%barbios+do+Desenvolvimento>) and the production of four books with open and free access (<https://www.mackenzie.br/pos-graduacao/mestra>

[do-doutorado/sao-paulo-higienopolis/disturbios-do-desenvolvimento/livros-de-acesso-aberto/\).](http://do-doutorado/sao-paulo-higienopolis/disturbios-do-desenvolvimento/livros-de-acesso-aberto/)

In continuity with this type of performance, in 2015, an interdisciplinary project was initiated, along with the Education Secretary of Embu das Artes, aimed at the development and implementation of a standardized process model for screening and evaluating students with school complaints and signs of neurodevelopmental disorders. The project, coordinated by Prof. Maria Cristina Teixeira, includes four frameworks: Autism Spectrum Disorder, Intellectual Disability, Specific Learning Disorders and Attention Deficit Hyperactivity/Impulsivity Disorder. Several steps make up the project, such as the development of screening instruments that can indicate signs, observable by teachers, of these four frameworks; availability of intervention to teachers, who can conduct it in the classroom, in order to observe the students' response to the intervention, an important data to continue the identification and intervention process; development of flowcharts and computer resources that assist the management team and teachers concerning the steps involved in the screening of these students.

Such projects illustrate how interdisciplinary work is fundamental for understanding and working with complex problems of Early Education, as well as offering examples on how the PPG-DD has conducted supports, intersecting teaching, research and extension in interdisciplinary proposals aimed at education. We hope that, increasingly, the interdisciplinary view will be fostered, as we have observed that as proposed by Jupiassu, Gusdorf, so many other researchers and by CAPES itself: in

the dialogue among the disciplines and in the creation of new models of thought and performance that we will be able to make significant progress in facing issues as complex as our education.

REFERENCES

- American Psychiatric Association (1980). *Diagnostic and statistical manual of mental disorders* (3. Ed). Washington, DC: American Psychiatric Association.
- CAPES - Pessoal de Nível Superior (2019). *Documento de área – Área 45: Interdisciplinar*. Brasília: Ministério da Educação.
- Cesco, S., Moreira, R. J., & Lima, E. F. N. (2014). *Interdisciplinaridade: entre o conceito e a prática* (Interdisciplinarity between concept and practice). *RBCS*, 29, 57-71.
- Fazenda, I. (1979). *Integração e interdisciplinaridade no ensino brasileiro: efetividade ou ideologia* (Integration and interdisciplinarity in Brazilian education: effectiveness or ideology). São Paulo: Loyola.
- Gusdorf, G. (1976). Prefácio. In: H. Japiassu (Org.), *Interdisciplinaridade e patologia do saber* (Interdisciplinarity and pathology of knowledge) (p. 7). Rio de Janeiro: Imago.
- Japiassu, H. *Interdisciplinaridade e patologia do saber* (Interdisciplinarity and pathology of knowledge). Rio de Janeiro: Imago.
- Japiassuú, H. (2006). O espírito interdisciplinar (The interdisciplinary spirit). *Cadernos EBAPE.BR*, IV(3), 1-9.
- Mateus, A. F. (2015). A comunicação nas ciências interdisciplinares: o compromisso de um discurso – o caso da área da Saúde (Communication in interdisciplinary sciences: the commitment of a discourse - the case of the health area). *Estudos em Comunicação*, 21, 177-188
- Nissan, M. (1997). Ten cheers for interdisciplinarity: The case for interdisciplinary knowledge and research. *Social Science Journal*, 34(2), 202-217.
- Ortega y Gasset, J. (2004). *Obras completas (Volumen I)*. Madrid: Taurus/ Fundación José Ortega y Gasset.

Paviani, J., & Botomé, S. P. (1993). *Interdisciplinaridade, disfunções conceptuais e enganos acadêmicos* (Interdisciplinarity, conceptual dysfunctions and academic mistakes). Caxias do Sul: EDUCS.

Skrtic, T. M. (1996). La crisis del conocimiento de la educación especial: una perspectiva sobre la perspectiva (The knowledge crisis of special education: A perspective on perspective). In: B. M. Franklin (Org.), *Interpretación de la discapacidad* (pp. 35-72). Barcelona: Pomares-Corredor.

CHAPTER 2

Culturally relevant pedagogy: an interdisciplinary approach to developing cultural fluency about the Sateré-Mawé

Elisa Macedo Dekaney

Elizeu Coutinho de Macedo

In recognition of student diversity in the United States, educators have been challenged to reconceive their teaching approaches aiming to reflect inclusive teaching practices that are culturally relevant (Richards, Brown, & Forde, 2007). Similar considerations to embrace student diversity in Brazilian classroom would be befitting because of similar historical colonization practices exercised by Western European cultures over Afro-descendants and Indigenous peoples.

Therefore, this chapter introduces the concept of Culturally Relevant Pedagogy (CRP) and challenges educators to implement intentional and transformative curricular changes that considers the perspectives of students who come from minoritized groups as well as those who belong to the dominant group. Through an analysis of the current status of the Indigenous people of Brazil, the authors propose interdisciplinary classroom activities based on the cultural traditions of the Sateré-Mawé.

CULTURALLY RELEVANT PEDAGOGY (CRP)

Culturally Relevant Pedagogy (CRP) “is a pedagogy that empowers students intellectually, socially, emotionally, and politically through the use of cultural references to transmit knowledge, techniques, and attitudes” (Ladson-Billings, 1994, p. 17-18). The idea of CRP was coined by Ladson-Billings in 1995, when she began to consider practical ways to improve teacher education. Ladson-Billings envisioned a new generation of teachers who could appreciate their students’ knowledge and experiences, and incorporate these experiences into their work in urban classrooms, which were populated mostly with African Americans (Ladson-Billings, 2014). One crucial element in culturally relevant teaching is the understanding of the social, cultural, political, and emotional context upon which students are inserted. Instead of imposing the views, ideas, and concepts of the dominant group, culturally relevant teaching aims to use the students’ social, emotional, and economic locations to inform teaching practices and curriculum within a certain classroom.

Furthermore, Ladson-Billings (2014) explained that CRP focused on three main pivotal domains identified in the work of educators who had implemented principles of this approach. The first of the three domains, academic success, considered how teachers who implement CPR are committed to their students’ academic success as measured by the intellectual growth and curiosity that students experience in a culturally relevant classroom with appropriate learning activities. The second domain, cultural competence, identified that teachers who implement CRP

seek to promote their students' appreciation for their culture of origin while learning about and being fluent in at least one other culture, leading to the development of cultural competence. And the third domain, sociopolitical consciousness, described how teachers who implement CRP develop the ability to expand learning beyond the classroom by "using school knowledge and skills to identify, analyze, and solve real-world problems" (Ladson-Billings, 2014, p. 75) with the ultimate goal of developing a sociopolitical conscience.

Implementing an inclusive teaching environment in Brazilian classrooms would mean promoting and celebrating the various ethnic and cultural groups that constitute the complex cultural, social, and economic landscape in Brazil. Including students with disabilities in mainstream classrooms is another critical consideration and is paramount to a society that seeks to promote an equitable education. Likewise, re-examining the school curricula to include representation and contributions of various ethnic and cultural groups is fundamental to promoting an environment in which every Brazilian child is respected and can envision and claim their rightful place in society. Applying the cultural competence principle embedded in Culturally Relevant Pedagogy (CRP), teachers may provide a learning experience and classroom environment in which students develop an appreciation for their own culture while gaining fluency in one other culture. In the case of Brazil, elevating the contributions of Indigenous Brazilians and Afro-descendants seems an appropriate direction.

BRAZILIAN DEMOGRAPHIC DATA

Data from the IBGE 2000 Census revealed that in a population of 170 million Brazilians, 53.4% identified as White, 6.1% as Black, 38.9% as Brown, 0.5% as Yellow (Asian) and 0.4% as Indigenous. In the subsequent IBGE 2010 Census, the numbers were similar; however, there was an increase in Afro-descendants' self-identification with more than 50% of the 191 million Brazilians identifying as Black and Brown (7.6% as Black, 43.1% as Brown) and less people identifying as White (47.7%). The number of Asians increased to 1.1% while the number of Indigenous peoples remained unchanged (0.4%). The Afro-descendants' self-identification may signal an increase in racial awareness among the mixed population, a trait that was not as overt in previous census (<https://agenciadenoticias.ibge.gov.br>).

Should this demographic census data influence what is taught and how teachers deliver instruction in Brazilian classrooms? Given that minoritized groups have been consistently left out of the standard classroom resources and pedagogical books used in most Brazilian classrooms, it seems that demographic data should inform the scope of the curriculum and the mode of delivery. But how should the representation of Blacks, Browns, Indigenous, and Asians make its way into the classroom? Sometimes, it is easy to simplify what it means to implement CRP by including in the curriculum a few examples of works by women, marginalized populations, people of color, or people with disabilities. However, this simplification is often executed without proper context and deep cultural meaning (Banks, 2004). It is tempting, for some educators,

to simplify the inclusion of “others” into the school curricula by planning some activities on special celebratory days. For instance, students may do a crafted headpiece and paint their faces to celebrate Indigenous People (*Dia do Índio*). Some teachers may select a Jewish song to acknowledge Yom HaShoa. And others may show a documentary about *Zumbi dos Palmares* during Black Awareness Day (*Dia da Consciência Negra*). Nonetheless, these attempts are most often void of contextual, cultural, artistic, and educational meaning. Additionally, they are not taught in an interdisciplinary manner and frequently leave out important contextual facts that are imperative to the development of cultural competence and fluency as signaled by Ladson-Billings. The challenge for educators is to intentionally design and implement a curriculum that elevates the representation of minoritized groups in a meaningful way. To achieve that, one must go beyond special “day” celebrations and distribute these learning experiences across the entire academic year.

An intentional inclusion strategy for teachers that reflects the diversity of the Brazilian population may reflect the following:

1. Elevate cultural traditions of the Indigenous peoples of Brazil
2. Elevate cultural traditions of African descendants in Brazil
3. Disseminate culture of various global communities in Asia, Middle East, and other people who have contributed to Brazilian society
4. Continue to disseminate the Western European tradition without diminishing the contributions of others

CULTURAL COMPETENCE

Ladson-Billings (1994) acknowledged that teachers committed to CRP are themselves culturally competent and use their students' experience to celebrate their culture of origin while assisting them in gaining knowledge of and fluency of at least one other cultural tradition. Perhaps, it would make sense for students in Brazilian classrooms to gain fluency in one of the Indigenous groups who live in Brazil.

It is estimated that prior to the arrival of the Portuguese in Brazil there was a population of approximately six million Indigenous people speaking more than 1270 languages. Nowadays, 85% of these languages have disappeared; there are only about 180 languages. The Indigenous population decreased to about 500,000 and divided into 234 ethnic groups, living in thousands of villages in isolated places or in reservations designated by the government (Kahn, 2011). *“The disappearance and systematic destruction of the Brazilian Indian are not just problematic in terms of sheer number of lost lives, but also the extinction of more than 500 diverse ethnic groups and the thousands of years of their cultural heritage, evolution, and survival”*(Gomes, p. 2). Surprisingly, Brazilian Indians have resisted centuries of colonial oppression and demonstrated resilience and resistance to the dominant group by preserving some of its own cultural, social, economic, and belief traditions. This resistance and resilience are worth teaching and learning.

INDIGENOUS ACCULTURATION

For over two centuries, anthropologists have predicted that Brazilian Indian groups would be extinct. Recently, however, Gomes (2000) pointed to new and surprising evidence of population growth (Table 1). In his anthropological study of the history of the Indians and Brazil, he sought to analyze and interpret data and historical facts that may explain this “wondrous phenomenon” (Gomes, 2000, x).

The paradigms of acculturation indicated that if two ethnic groups met, the *stronger* would tend to overpower the *weaker* one. Sometimes the outcome of such encounters would result in integration or assimilation of the weaker into the more dominant culture. This paradigm, however, discounted the possibility that smaller groups can react against the imposition of the dominant culture and “preserve enough of its character to maintain its self-identity and accommodate itself to the new situation, without necessarily diluting itself into nothing” (Gomes, 2000, p. x). Gomes hypothesized that the breach in the paradigm aligned with the cracking of Western assurance and notions of superiority in the Indians’ mind. Further, better public health measures by the Brazilian Indian agency contributed to the current steadfast increase in population.

The fact is that – independent of any other cultural or political variable – in the last thirty or forty years the Indians have been experiencing a new, unexpected, and extraordinary development that we may unabashedly call “the Indian demographic turnaround.” (Gomes, 2000, p. 2). Nonetheless, this is by no means a statement that the Brazilian Indians have overcome centuries of assimilation, extermination, and

demographic decline. It is, however, an interruption of the extinction pattern experienced by thousands of Indigenous peoples. It is crucial to remember that “95 percent of an entire population was wiped out over a period of five centuries in which there are only a few decades of consistent recovery” (Gomes, 2000, p. 2).

Table 1. Sateré-Mawé Population

Year	Population
1987	4710
1991	5825
1999	6950
2000	7134
2002	7376
2010	10761
2014	13350

Source: https://pib.socioambiental.org/en/Povo:Sateré_Mawé

In an attempt to develop cultural competence by being fluent in one other culture, a case can be made for an interdisciplinary immersion in the Sateré-Mawé culture. Why? First, the Sateré-Mawé are among hundreds of Indigenous Brazilian groups who have been systematically destroyed and oppressed. Second, judging by their population growth, the Sateré-Mawé have defied the paradigms of acculturation and shown they are resilient. And lastly, Brazilians are proud of *guaraná*, an important element in Brazilian society and economy that is widely distributed and commercialized in Brazil and abroad. *Guaraná* belongs to the Sateré-Mawé; to disseminate and preserve their culture is to preserve Brazilian culture.

THE SATERÉ-MAWÉ IN THE MUSIC CLASSROOM: GUARANÁ

The story of *guaraná* is a central point in the history of the Sateré-Mawé Indians, who hail from the lower part of the Negro River, a tributary of the Amazon River, in a region known as Sateré-Mawé (Salerno, 2006). Of the etiologic type, the story explains not only the origin of a fruit from the Amazon forest but the very existence and origin of the Sateré-Mawé.

The story of *guaraná* has been retold by Almeida and Portella (2006), Dorson and Wilmot (1997), Fittipali (2005), and Salerno (2006). However, it has not been narrated in some of the earliest and most traditional accounts of Brazilian folk stories such as Cascudo (1997, 2001, 2006, 2010) and Romero (1885 and 1907). One possible explanation is that little was known about the Sateré-Mawé by Romero and Cascudo. Another possibility is that Indigenous people narratives were excluded from the dominant discourse and had not yet been considered worthy of being captured, thus the need for meaningfully including them in mainstream pedagogical resources.

Guaraná is a fruit believed to provide strength and energy. The Indians used to drink a *guaraná* beverage prior to and during hunting. Kahn (2011) explained that the Sateré-Mawé discovered the energetic power of *waraná* thousands of years ago. The drink they still prepare hitherto is called *sapó*, a bitter beverage with very little similarities to the popular soda drink from Brazil called *guaraná*. The men are responsible for grinding the seeds until they resemble a stretchy dough; the women transform that into a stick and let it smoke for months until it

is completely dark, dry, and hard. The women then shred the smoked stick and wash it in the river. Traditionally, the women are responsible for shredding the *guaraná*; the Sateré-Mawé men only engage in this activity when are traveling alone, hunting, or fishing.

In 1650, European priests learned about *guaraná* and its properties. The fruit, they concluded, provided energy, minimized hunger, could be used as a diuretic, and also eliminated fever and headaches (Salerno, 2006). This fruit, with so many different applications, has become part of the fabric of Brazilian culture, cuisine, medicinal practices, and economy.

CONCLUSION

Teachers who implement Culturally Relevant Pedagogy are culturally competent and seek to promote their students' appreciation for their culture of origin while learning about and being fluent in at least one other culture, leading to the development of cultural competence. Given the historical colonization practices imposed by Western European cultures over Afro-descendants and Indigenous Peoples in Brazil, it is imperative to find ways to include the narratives and stories of minoritized groups frequently excluded from pedagogical books and materials.

In this way, students who belong to minoritized groups will be challenged to develop an appreciation for their own culture. Likewise, students from the dominant group may develop a cultural fluency in one other culture, in this case, the Sateré-Mawé. To fully embrace student diversity in the Brazilian classroom, teachers and pedagogues must

intentionally elevate the stories and narratives of minoritized groups meaningfully throughout the academic year and not only on special celebratory days.

After teaching and learning about the historical, cultural, and socio-economic contexts of the Sateré-Mawé in an interdisciplinary way, teachers from various areas can address specific aspects of their own disciplines. For instance:

1. A biology teacher may assist students in exploring the Amazon ecosystem; a social studies teacher may explore sustainable ways of *guaraná* production in the Sateré-Mawé organic farms

(https://www.youtube.com/watch?v=Tb_jWXvBPA8&t=360s);

2. A music teacher may plan a activity in which students compose with instruments and with voice sounds that represent the biodiversity of the Amazon rainforest as in this example (Samba Laranja Album *Guaraná* available at

<https://open.spotify.com/album/2RUZNX2bV9rWldfluJcLot>;

3. A visual art teacher may invite students to create artwork that depicts the story of *guaraná*. There are infinite creative possibilities to assist students in developing cultural fluency about the Sateré-Mawé.

In conclusion, this chapter introduced the concept of Culturally Relevant Pedagogy and the impact its meaningful implementation can have on students' learning, whether students are members of minoritized groups or belong to the dominant group. The adoption of culturally rel-

event pedagogy practices can be intentionally incorporated into the curriculum with the goal of implementing well-designed interdisciplinary practices that will lead to meaningful learning experiences. The authors supported their approach to implementing a culturally relevant curriculum by proposing the study of the Sateré-Mawé, an Indigenous group whose rich cultural practices have impacted and contributed to Brazilian economy, customs, and habits.

REFERENCES

- Almeida, L. & Portella, A. (2006). MacDonald, M. R. (ed). *Brazilian folktales*. Westport, CT: Libraries Unlimited.
- Banks, J. A. (2004). Multicultural education: Historical development, dimensions, and practice. In J. A. Banks and C. M Banks (Eds), *Handbook of research on multicultural educational* (pp. 3-30). San Francisco, CA: Jossey-Bass.
- Cascudo, C. (1997). *Contos tradicionais do Brasil* (Traditional Folktales of Brazil). Rio de Janeiro, Brazil: Ediouro.
- Cascudo, C. (2001). *Lendas brasileiras* (Brazilian legends). São Paulo, Brazil: Global Editora.
- Cascudo, C. (2006). *Contos tradicionais do Brasil para jovens* (Traditional tales of Brasil for the youth) (2nd ed.). São Paulo, Brazil: Global Editora.
- Cascudo, C. (2010). *Lendas brasileiras para jovens* (Brazilian legends for the youth) (2nd ed.). São Paulo, Brazil: Global Editora.
- Dorson, M. & Wilmot, J. (1997). *Tales from the rain forest: Myths and legends from the Amazonian Indians of Brazil*. Hopewell, NJ: The Ecco Press.
- Fittipaldi, C. (1986). *A Lenda do Guaraná: Mitos dos Índios Sateré-Maué*. São Paulo, Brazil: Melhoramentos.
- Gomes, M. P. (2000). *The Indians and Brazil*. Gainesville: University Press of Florida.

- Kahn, M. (2011). *ABC dos povos indígenas no Brasil* (ABC of the indigenous people of Brazil). São Paulo, Brazil: Edições SM.
- Ladson-Billings, G. (1994). *The dreamkeepers: Successful teachers of African American children*. San Francisco: Jossey-Bass.
- Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal*, 32(3), 465-491.
- Ladson-Billings, G. (2014). Culturally relevant pedagogy 2.0: a.k.a. the Remix. *Harvard Educational Review*, 84(1), 74-135.
- Richards, H. V., Brown, A. F., & Forde, T. B (2007). Addressing diversity in schools: Culturally responsive pedagogy. *Teaching Exceptional Children*, 39(3), 64-68.
- Romero, S. (1885). *Contos populares do Brasil* (Popular tales from Brazil). Lisboa, Portugal: Nova Livraria Internacional Editora.
- Romero, S. (1907). *Contos populares do Brasil* (Popular tales from Brazil). Rio de Janeiro, Brazil: Livraria Francisco Alves.
- Salerno, S. (2006). *Viagem pelo Brasil em 52 histórias* (Journey around Brazil in 52 stories). São Paulo, Brazil: Companhia das Letrinhas.

CHAPTER 3

Inter-Institutional Doctorate (DINTER) in Development Disorders for teacher training and its contribution for public policy in Maceió, Alagoas

Silvana Maria Blascovi-Assis

Evanisa de Maio Brum

Renata Sampaio Rodrigues Soutinho

Luiz Renato Rodrigues Carreiro

INTRODUCTION

The inter-institutional Doctorate — DINTER — is presented as a proposal of Coordenação de Aperfeiçoamento de Pessoal do Nível Superior (Coordination for the Improvement of Higher Education Personnel) - CAPES aiming at postgraduate training of human resources qualified for the socio-economic-cultural, scientific-technological development and innovation. Besides, one of the main goals focuses on training teachers who, once trained and certified, may be responsible for nucleation of new *stricto sensu* graduate studies programs in regions with fewer opportunities for a teaching qualification.

According to the Notice No. 2/2016 of CAPES, such programs are designed to enable the formation of masters and doctors outside the centers consolidated of teaching and research, with the same standard

of quality and to explore the potential of graduate programs already consolidated in order to support the training of teachers for the various levels of education. This action should be directed to subsidize the nucleation and the strengthening of teaching and research groups; to strengthen and establish the conditions for the creation of new postgraduate courses and to contribute to the building of specialized and cooperative environment of innovation for education and training of human resources and the expansion of national productive environment (CAPES, 2016).

THE PROMOTER INSTITUTION VIEW

The DINTER proposal between the Graduate Program in Developmental Disorders (PPG-DD) of Mackenzie Presbyterian University (MPU), which in this agreement is configured as a Promoter Education Institution and the FEJAL/CESMAC (Jayme Altavila Educational Foundation), Alagoas, as Receiving Education Institution, reconcile with the solidarity ideal established by MPU to foster an ongoing policy of teachers and researchers training, particularly tied to regional interest topics insufficiently met in the country, serving in this way the defined objectives by CAPES specific Ordinances (Sucupira Platform, 2017).

The receiving institutions should be supported to create and to strengthen research topics with an emphasis on regional characteristics and needs and identifying new vocations for search among the student framework through the participation of scientific initiation fellows in scientific projects.

The partnership between MPU/Cesmac institutions was the result of a serious and consolidated investment of teachers' team who makes

up the PPG-DD throughout its trajectory, which culminated in getting grade 6 (six) of the Program in 2016. In order to meet more and more the CAPES guidelines and to invest in “solidarity and social inclusion” category, which is encouraged by the evaluation body to programs that minimally obtained a grade equal to or greater than 5 (five) in the Triennial Assessment, MPU found a partner institution with the same desired objectives for the implementation of DINTER: interest in empowering their teachers and present future multipliers proposals for master and doctorate courses in the state of Alagoas.

This partnership resulted in an agreement between the institutions, following the CAPES guidelines and design. Conceptualized since 2016, it was effectively implemented in the Centro Universitário Cesmac – Cesmac (Cesmac University Center) in Maceió / AL, in the second half of 2018, meeting the CAPES regulations regarding solidarity, a category in which the Program must demonstrate cooperation with programs that got a score of 3 (three) or 4 (four) or groups that still do not have *stricto sensu* postgraduate studies, to promote the creation and consolidation of courses, especially in other regions of the country or in countries with a less developed level in postgraduation courses. (Figure 1).

The Interdisciplinary area shows the careful evaluation of *stricto sensu* programs, focusing only 10 (3%) of the programs with grade 6 (six) and 2 (1%) with grade 7 (seven). Thus, the PPG-DD, with its grade 6 (six), is shown as a potential trainer of doctors in the area, contributing, with the implementation of DINTER, to expand the training of doctors in the permanent staff of teachers from distant institutions of the great centers

of learning and research, in order to reduce the currently existing asymmetries and to foster academic production in the assisted institutions, which respond to the demands related to local and regional development (CAPES, 2016).

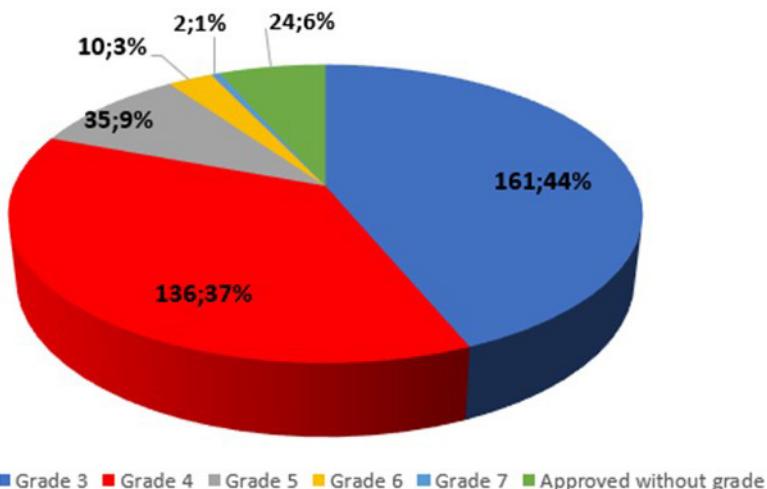


Figure 1. Distribution by the grade of the Interdisciplinary Area graduate programs recommended by CAPES (adapted). Source: DAV / CAPES, 06/17/2019. (Capes, 2019)

Alagoas, in terms of number of Graduate Courses Stricto Sensu recognized by CAPES, at the time of the survey and proposal, was the north-eastern state with the lowest number of offered courses, representing 4% of total courses of this nature that were offered in the region. Moreover, it can be observed that from the approved and recognized courses by CAPES, there is a significant shortage of courses with the emphasis on studies of developmental disorders in the education, health and psychology context (Figure 2).

The interdisciplinary character that permeates the PPG-DD, since its conception in 1998, has been reproduced and maintained to the configuration of the selection process that occurred for the composition of students' body. The target audience of DINTER proposal were teachers of the receiving institution, which should be linked to the courses offered by IES Receiving.

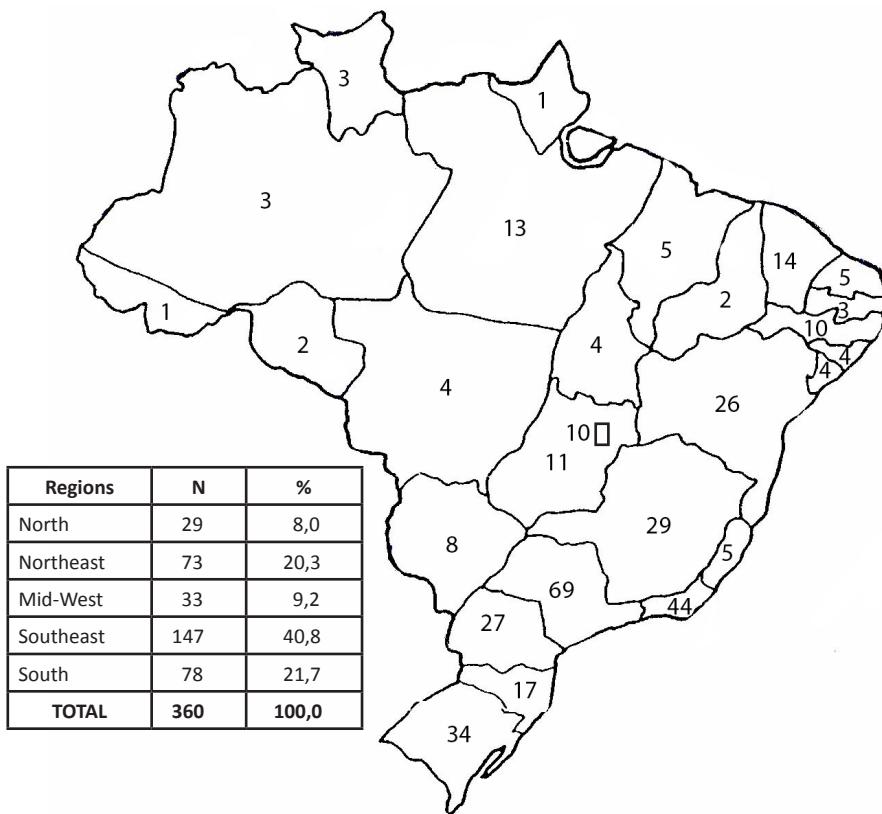


Figure 2. Distribution of the Interdisciplinary Area graduate programs per state of the Federation. Source: Sucupira Platform, 21/01/2019. The inserted table shows the absolute number and the percentage of programs by the Brazilian geographic region. (Source: CAPES, 2019).

After careful selection, which took place with the participation of the two institutions, DINTER interdisciplinary student body was created. It was composed by ten students, teachers of undergraduate courses and with training in Pedagogy, Psychology, History, Physiotherapy, Nursing and Physical Education areas, whose work would be conducted in three traditional lines of PPG-DD research: a) Studies of the development and its disorders in the clinical, cognitive, behavioral and epidemiological areas: Individual and Social Implications; b) Neuroscience of development: an investigation of the determinants neural basic mechanisms or are involved in the establishment of the developmental disorders and c) Policies and forms of assistance in education, psychology and health: study of national policies related to people with disabilities, specialized procedures and public and private assistance programs.

Above all, the idea of conducting projects that could support proposals that benefit actions to public policies in the region in the health and education areas should be addressed considering the regionality and targets of social inclusion. This impact, directly planned – through the researchers' group actions, or indirectly - by multiplying professionals who can act in the city, in the state, in the local Universities or regional Institutions may occur from the interdisciplinary training and the future creation of the training courses on the initiative of the formed group by DINTER (Figure 3).

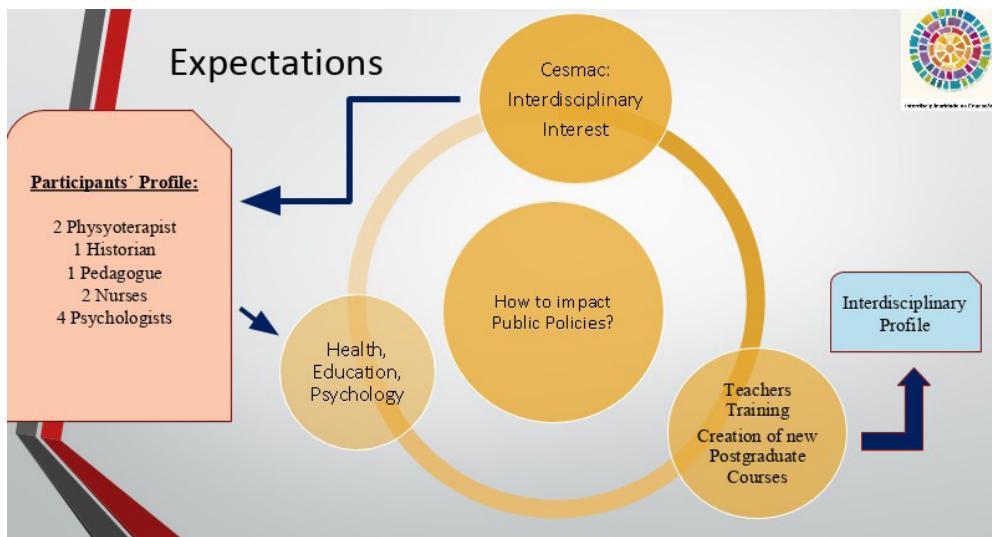


Figure 3. Impact Expectations in public policy from the interdisciplinary training
(Source: the authors)

Respecting the interests of newcomers and the affinities with the lines of research, the teaching staff of IES Promoter was made up to face the challenge of the proposal implantation, encompassing the classes to be held in the IES Receiving and the orientation process of newcomers. The group consisted of seven teachers with the interdisciplinary formation and members of the three lines of research: Alessandra Gotuzzo Seabra, psychologist; Decio Brunoni, geneticist doctor; Elizeu Coutinho de Macedo, psychologist; Luiz Renato Rodrigues Carreiro, psychologist; Maria Eloisa Famá D'Antino, pedagogue; Paulo Sergio Boggio, psychologist and Silvana Maria Blascovi de Assis, physiotherapist.

Thus, this project started in 2018 and has its completion scheduled by 2022. It is intended to bring to the Maceio region, Alagoas, signifi-

cant scientific improvement opportunities that can reflect on actions that benefit the public policy and the region's population in the next years.

THE RECEIVING INSTITUTION VIEW

The FEJAL / CESMAC is located in Maceio, the capital of Alagoas, which has an estimated population of 1,021,709 inhabitants. Alagoas has the lowest Human Development Index (0.631) and the penultimate per capita income in Brazil. Regarding the Basic Education Development Index (IDEB), carried out in the year of 2016, Alagoas had one of the worst grades in the country for the third consecutive time, and lower enrollment rates than the national average, according to the 2015 National Sample Survey of Households (IBGE, 2019). Maceio follows the same pattern of Alagoas state because the municipality has low income; 39% has nominal monthly income up to half minimum wage and the per capita of average income of 2.7 minimum wages. Sum up the above that according to the latest map of poverty and inequality, provided by IBGE, shows Maceio with 58% of poverty incidence. As for education obtained grade 3 (three) in IDEB, on a scale from 0 to 10, in the evaluation of the final years of elementary school. In addition, in the 6 to 14 aged group, it shows one of the worst enrollment rates in Brazil as, among 5570 municipalities, it occupies the 5014 position. Furthermore, most children who enter elementary school did not attend kindergarten (IBGE, 2019). From these indicators, it is possible to realize the difficulties encountered in the city of Maceio and the State of Alagoas.

Maceió has a Municipal Education Secretary (SEMED), in which 130 public schools in operation are linked, divided into eight administrative regions. These institutions offer early childhood education, elementary school and education of youth and adults (EJA) to 49,622 students enrolled, from which 2,321 are in special education in the dual enrollment form, referring to regular school and to the service called Specialized Education Assistance (INEP, 2015).

Despite the own investments and in technical cooperation with the Ministry of Education, the reality of Maceió Municipal Education Network presents still an unsatisfactory framework concerning the Basic Education Development Index (IDEB), at the moment, as well as regarding the quality of teaching practice developed at schools (Barbosa & Fumes, 2018).

For special education, the municipality seeks to follow the direction of national legislation regarding the principles of inclusive education in a mainstream school environment for the target audience of Special Education (BRAZIL, 2008). The last Brazilian School census shows that in Maceio, the students were enrolled in shared rooms and in the Specialized Service Assistance (BRAZIL, 2016).

The city still has a long way to go as it relates to special education from the perspective of inclusive education (Barbosa & Fumes, 2018). In this regard, four projects linked to Dinter are being carried out in the school context of Maceio. The first one is aimed at analyzing the knowledge, practices and attitudes of elementary school 1 teachers about Autism Spectrum Disorder (ASD) in municipal schools in the city of Maceio.

The second project aims to describe the mode of operation of the Multifunction Resource Rooms of the inclusive municipal network in Maceio and to verify how the Public Policy subsidizes the operation of these rooms. The third one will involve modeling, development and evaluation of an application with artificial intelligence usage to detect ASD by teachers from the public network in Maceio. Finally, the fourth will examine children diagnosed with cognitive difficulties from elementary school 1 in the same network to identify signs of ADHD, Dyslexia and Intellectual Disability.

Besides, linked to the health and in the context of Down syndrome (DS), two studies are being carried out: the first aims to design, develop and evaluate an application for toilet training in children in early childhood with DS. The second study is to identify if the training of the expiratory muscles is effective at increasing expiratory muscle strength and the levels of care and quality of sleep in children with DS. Finally, an umbrella project will be realized that aims at conducting a cross-cultural study on affection, morals and sociability in the Quilombola community, composed of an Afro-Brazilian ethnic group, and the indigenous population of Alagoas.

Starting from the indicators presented, the Receiving institution plans to train the students involved in DINTER to contribute to the improvement of public policies for Basic Education, especially for specialized education within the kindergarten and elementary school scope in the region, including academic training of doctoral students so that they can proceed in the region with the development of assessment and ear-

ly intervention actions that aim to promote positive child development and mitigate the impact that many developmental disorders produce in children, adolescents and families. It is also expected that the Ph.D. students instrumentalize themselves with a background in research in such a way that they can develop research projects in the region focused in education, psychology and health directed to child development and its disorders as well as they can contribute qualitatively with Cesmac using their research practice and teaching.

THE DINTER STUDENTS BODY VIEW

The student sees the DINTER in Developmental Disorders (UPM / Cesmac) as an excellent opportunity for a professional qualification, research consolidation in the institution and to have a product capable of affecting the social reality of our state. The student body is made up of professionals in the areas of psychology, pedagogy, nursing, physiotherapy and history with an interdisciplinary work profile. It is highlighted that in the state of Alagoas has only three programs in the interdisciplinary area (CAPES, 2019). The interdisciplinary is considered a valuable tool to generate professional, social, educational, technological, economic, cultural and artistic impact, which demonstrates the importance of the program.

In the face of the State of Alagoas scenario, considering the numerous complete and complex problems that require collaboration, innovation, dialogue, questions and experiences exchanges, the projects are being developed in populations that are most affected with the so-

cio-economic scenario as schoolchildren; ADHD, dyslexia and learning disabilities, ASD and DS children; quilombolas and indigenous.

An important bridge for the group was the visit to the UPM laboratories and assistance services, where it has access to protocols developed by program teachers and differentiated technological resources. As it facilitates the research in our institution, promoting academic research, strengthening research lines, which meet the demands related to local and regional development, taking into account the objectives of interinstitutional programs proposed by CAPES.

These visits, which are part of the doctoral training proposal at another university, provides students the experience in other research centers, in a city with a different reality. From an academic point of view, it is an opportunity to meet a new education structure that brings them new knowledge (Torres, 2016). Besides being together with postgraduate colleagues, the opportunity to participate in events with national and international speakers are part of the programming for the group.

The challenges are countless and are related to the distance, to the public policy of the State of Alagoas, to financial investment and to other professional demands. By contrast, there is a great effort and commitment to contribute to the reduction of the rate in reality worthy of actions, favoring the creation and consolidation of new research groups, teaching and extension, creating conditions for the expansion of investigations that are dedicated to face challenges in understanding the disorders/disabilities people or vulnerable populations.

FINAL CONSIDERATIONS

Thus, the challenge that motivates both the promoter and the receiving institutions is that, through this partnership, the experience in interdisciplinary research experienced by a group of teachers from the Southeast can be replicated in a region of the country, which has its characteristics of development.

Providing, through the training and qualification of its teachers, research activities and encouraging, that in the future, this group can implement a stricto senso program in the area viewing to academic and social activities, in collaboration with the public policy of the Alagoas region

REFERENCES

- Barbosa, M. & Fumes, N. (2018). *Educação especial no município de Maceió/Alagoas: a fragilidade das políticas públicas* (Special education in the city of Maceió / Alagoas: the fragility of public policies). Cadernos Cedes, Campinas, 38:(106), 281-298.
- BRASIL (2008) *Política Nacional de Educação Especial na Perspectiva da Educação Inclusiva* (National Policy on Special Education from the Perspective of Inclusive Education). Brasília, DF: MEC.
- BRASIL (2016). MEC. *Censo Escolar 2016* (School Census 2016). Brasília, DF: MEC.
- CAPES. Dinter (2016). Available at: <https://capes.gov.br/bolsas/bolsas-no-pais/dinter> Accessed 02/03/2020.
- CAPES. *Documento de área Interdisciplinar* (2019) (Interdisciplinary area document). Available at: https://capes.gov.br/images/Documento_de_%C3%A1rea_2019/INTERDISCIPLINAR.pdf Accessed 02/03/2020.
- IBEG, Instituto Brasileiro de Geografia e Estatística (2019) (Brazilian Institute of Geography and Statistics). Available at: <https://www.ibge.gov.br/> Accessed 15/09/2019.

INEP, *Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira* (2019) (National Institute of Educational Studies and Research Anísio Teixeira). Available at: <http://portal.inep.gov.br/> Accessed 15/09/2019.

Plataforma Sucupira. Annual report of the Postgraduate Program in Developmental Disorders (2017).

Torres, M.H.C. (2016). *Cooperação e parceria nacional no Brasil: quase 10 anos de sucesso do doutorado interinstitucional* (Cooperation and national partnership in Brazil: almost 10 years of success of the interinstitutional doctorate). Revista de Letras, 33(2):75-81.

CHAPTER 4

Challenge based learning as a transformational method of the educational process

Joaquim Pessoa Filho

Ilana A. Souza Concilio

Pedro H. C. Braga

INTRODUCTION

Computing has become ubiquitous and the environments and devices with which people interact have been enriched with new possibilities for communication and interaction (Pacheco & Souza-Concilio, 2014).

The wide variety of technological resources today promotes the creation of new work fronts in the area of ICT (Information and Computer Technology) and, consequently, causes a need to readjust current teaching standards in order to prepare students for the labor market and their future role in the society. It is necessary to rethink how education uses technology, as this new digital world also requires educators to adapt and adopt digital technologies, methodologies and mentalities (DMI, 2020).

According to Mochizuki & Bruillard (2019), digital education stakeholders believe in the promises of digital technology to “revolutionize” or “interrupt” ineffective education models. The authors also claim that

greater use of digital technology in education envisions schools where students acquire 21st century skills in a personalized and collaborative manner and at their own pace, with teachers acting like facilitators of learning.

With roots in experimental learning, in which the student has an active participation in the educational process, Challenge Based Learning (CBL) emerged as an alternative to the traditional models in course. Stimulated by digital transformation and consolidating the use of technology as a fundamental resource in the process of building knowledge, this approach allows more personal and collaborative learning experiences.

The use of CBL as a teaching approach has been shown to be effective not only in the educational field, but also in the personal development of students, stimulating and improving skills such as leadership, creativity, problem solving (Johnson & Adams, 2011) and also increasing engagement, motivation and performance. The teacher's role also undergoes a transformation, ceasing to be responsible for the control and transfer of content and becoming a mentor or facilitator, that is, a collaborator in the learning process, facilitating the development of collaborative knowledge (Oliveira, 2016).

This chapter presents the evolution of educational practices in recent decades, being related to the current business models, in order to establish a relationship between the role of the teacher in the formation of good professionals and the establishment of efficient professional models.

EDUCATIONAL JOURNEY

There are currently a large number of educators discussing new ways of teaching and learning in order to provide greater student engagement. The digital transformation is demanding an educational transformation, from the adaptation of curricular grids to include content involving new technologies, systems and professions to the modernization of teaching and teacher training methods.

In 1938, in his book *Experience and Education*, John Dewey was already talking about old education (traditional method) and new education (progressive). The author argued that traditional learning means capturing content that was already embedded in books and in the head of older books, tied in the past and offering little help to deal with present and future issues (Dewey, 1938). He stated that static objects and materials are opposed by a changing world and insisted on creating a new educational philosophy based on learning from experience.

Dewey (1938) stated that traditional teaching was not completely against experimental philosophy, but that the experience provided within the walls of the classrooms did not continue outside them and that it did hurt the principles of evolution. Believing that the link between experience and education promotes a closer relationship between educator and student, the role of teachers should also be rethought, as they were the agents through which knowledge and skills were communicated as well as rules of conduct imposed. Hence, the role of educator should be to discriminate educationally appropriate experiences and guide students on the direction the experience is taking.

Following Dewey's reasoning in 1964, Piaget reinforced the theory that experience is a basic factor in the development of cognitive structures. In his constructivist theory, he stated that the fundamental relationship involved in all development and learning is assimilation, or rather, the integration of any type of reality into a structure from the point of view of didactic applications. The author defended that (PIAGET, 1964):

- the whole problem to be studied must be related to the student's reality or environment, starting from a familiar point;
- searching must be stimulated, in order to make the arrival point instigating and challenging;
- one should not explain everything to the student, leaving him to discover new things based on his own effort;
- teamwork is essential for socio-cognitive development, in which the exchange of ideas and various points of view stimulate the perception and the ability to explore problems from several different angles;
- The teacher should not be the owner of the content, but a mediator between students and knowledge, guiding throughout the process, showing new paths and not allowing them to keep making the same mistakes.

In 1984, David Kolb created his own model of experiential learning based on Dewey's theories. According to Miettinen (2000), his proposal was not to develop an alternative theory of learning, but to suggest through the theory of experiential learning a holistic integrative perspective of learning combining experience, perception, cognition and behavior.

With this experiential vision rooted in the pedagogical theories of Dewey, Piaget and Kolb, and also driven by the advancement of technology, the study of innovative and transformative teaching methods has become a relevant and prominent subject in the academic community. It took years for educators and educational institutions to consider modernization in the teaching and learning process.

According to Mochizuki & Bruillard (2019), we are currently working on the idea that digital technology connects students in new and powerful ways and frees up learning from past conventions. Technology facilitates interaction and learning. Increasing attention is also paid to the social foundations of learning, and learning is seen to involve not only the transformation of cognitive structures, but also participation in cultural practices. Motivation, interest and persistence of the student are important considerations for understanding the impact of technology-based pedagogy. At a certain level, the challenge for educators is linking this interest and familiarity with media to engage and improve students results.

CHALLENGE BASED LEARNING

Learning is a continuous cycle of a cognitive process involving constant adaptation. Over the years, several methodologies have been developed from theories of cognition and development of children and adults and are being applied to replace, at least partially, the traditional method based on lectures that still dominates current configurations of education (Abio & Stoyanova, 2018).

The social circumstances of the classroom and the student-teacher interaction play a significant role in motivating students, directly affecting the teaching-learning process. According to Abio & Stoyanova (2018), innovative teaching strategies are more effective in improving student motivation, knowledge retention, transversal skills and the general academic level.

Kolb's theory of experiential learning has gained popularity as an alternative to traditional didactic and behavioral approaches in the classroom, assuming that individuals create knowledge from experience, and not just from the instruction received. Conflicts, disagreements and differences lead the learning process, moving between modes of action, reflection, experience and reasoning (Bergsteiner et al., 2010).

Based on experimental learning, in which students learn better when actively involved rather than passively participating in academic activities, Apple Inc. developed Challenge Based Learning (CBL).

Challenge Based Learning is a teaching and learning methodology focused on real world problems to be explored from various angles and in a multidisciplinary way, strengthening the connection between what students learn at school and their perception outside school (Apple, 2011). The aim is also to encourage them to use technologies with which they interact in their daily lives to solve real everyday problems.

The concept, according to Apple Inc (Johnson et al., 2009):

“Challenge-Based Learning is a collaborative learning experience in which teachers and students work to-

gether to learn about important events, propose solutions to real problems and take action. The approach encourages students to reflect on their learning and the impact of their actions, publishing their solutions to a worldwide audience”.

According to Santos et al. (2015), CBL presents the following characteristics:

- teacher, students and stakeholders work as active collaborators in the learning process;
- inclusion of technical skills and professional life skills;
- focus not only on the final product, but on the process developed through reflection and publication of perspectives on what has been learned; and
- more time allocated to incorporate divergent and critical thinking.

In the CBL process, students must choose an area of research and propose a challenge to solve one of the real problems related to it. The idea is that, from this challenge, the student generates questions, which generates research and answers until they find an appropriate solution. Through a process of discussion and research, they identify a selection of issues that may be relevant to their projects. Figure 1 illustrates a parallel between the traditional learning process and CBL.

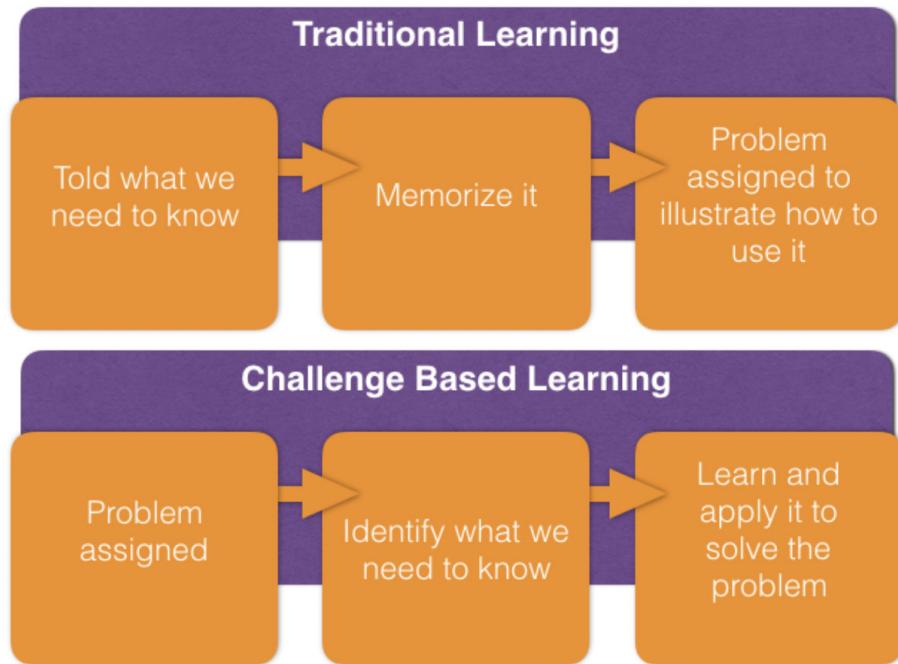


Figure 1. Parallel between traditional learning and CBL. Source: Henderson, S., Kinahan, M. & Rossiter, E. (2018). Problem-based learning as an authentic assessment method. PG Diploma in Practitioner Research Projects, DIT, 2018.



Figure 2. CBL approach steps. Source: Nichols, M., Cator, K., & Torres, M. (2016) Challenge Based Learner User Guide. Redwood City, CA: Digital Promise. Retrieved on February 15, 2020 from https://cbl.digitalpromise.org/wp-content/uploads/sites/7/2016/10/CBL_Guide2016.pdf

Figure 2 shows the stages of the CBL process (Nichols et al., 2016). All phases are continuously permeated by the processes of reflection, informative assessment and documentation of the learning process.

1. Engage - This phase starts with an area of interest and ends with the identification of a motivating and actionable challenge.

- Great idea - it is a broad area of research in which the student or developer wants to contribute. Some examples are: Education, Health, Sustainability, etc.
- Essential Question - within the scope of the Big Idea, there are some essential questions that, in the form of a question, represent a problem to be solved. As an example in education: how to increase children's motivation in the study of mathematics?
- Challenge - related to the Essential Question, the challenge is what the student or developer will have to solve. Following the example above: Create an interactive application (Learning Object) for teaching Mathematics to elementary school children.

2. Investigate - This phase is about questioning and research, with students acting actively in the process of formulating guiding questions, encouraging the acquisition of knowledge both individually and collaboratively. In the end, it is expected that students have successfully addressed all guiding questions and developed clear conclusions that will lay the foundation for the solution.

- Guiding questions - now that the student knows his challenge, he creates a list of questions that must be answered to validate the idea and solve any doubts about the problem, until the student or developer finds the best (or acceptable) solution for the challenge. These questions can be related to the problem or idea, as well as technical development issues.

- Activities and resources - list of activities and resources used to answer each guiding question.
- Analysis / Synthesis - after completing the guiding activity, students or developers create a synthesis that represents their findings during the research phase.

3. Act - Action that consists on the development, validation and evolution of the proposed solution.

- Solution - after all the previous process, the ideas are validated and some optimal solutions must be found and, in the case of more than one, another phase of reassessment and analysis of these solutions must be carried out until a single major solution is found.
- Implementation/Development - After working on the solutions, students implement, analyze and measure results, reflect on positive and negative points and determine their impact on the challenge.
- Evaluation/Refinement - When the implementation is complete, students can continue to refine the solution.

Nichols (2018) states that CBL contrasts with traditional didactic methods in which the teacher provides students with the necessary basic theoretical knowledge, controls content and restricts the role of students in the learning process. This approach transforms the roles not only of students, involving them in the learning process, but also of teachers who act as guides or mentors, connecting them with the possible resources and helping in the construction of new knowledge.

CBL makes learning relevant, giving students the satisfaction of discovering problems to be solved, tools to solve them and autonomy to define, validate and implement a solution (Johnson & Adams, 2011). It is the student's role to derive the challenge or problem they will face and, through a collaborative process of discussion and research, students identify a selection of questions that may be viable for their project, facing a challenge not only as individuals but also involved in the processes of their group.

In the belief that it is the individual who learns, mentors do not intervene during implementation, which allows the individual and the team to teach themselves (Gibson et al., 2017). With its collaborative character, it allows a greater interaction between students, stimulating and encouraging creativity and research, so that the student learns to study alone, promoting self-learning and establishing a direct and personal relationship with the acquisition of knowledge. Throughout the process, students are expected to reflect on their actions and also learn to work on critical thinking in relation to their own choices and results.

This model is often interdisciplinary and encourages projects that involve the community in general. There are reports of teachers who have implemented CBL in teams stating that collaboration with other teachers is one of the most beneficial and positive aspects of the approach to their own professional growth and development (Apple, 2011).

Although widely applicable in all learning environments, CBL encourages the use of web and mobile technologies to implement solu-

tions and publish results, forcing students to present their findings and reflections not only to the class, but also to the community (Educase, 2012).

According to Henry & Lima (2012) and Wan & Gut (2011), schools and teachers should focus on offering new opportunities to develop 21st century skills to promote innovative learning methods that integrate the use of technologies, experiential approaches and high order cognitive skills. There are authors who claim that a set of 12- key 21st century skills have improved significantly with the use of CBL, including leadership, creativity, problem solving, critical thinking, flexibility and adaptability (Johnson & Adams, 2011). In addition, it can also contribute to stimulate decision making, collaboration, and communication (Educase, 2012; Gibson et al., 2017).

CBL APPLIED TO SOFTWARE DEVELOPMENT

The different areas of knowledge continuously demand professionals with experience in software development, making professionals who are already employed need technical training in this area and, in parallel, many universities have readjusted their curricula in order to include content in the area of ICT (Information and Computer Technology) due to the fact that technology permeates these areas. On the other hand, the current scenario presented by Gallindo (2019) shows that Brazil, between the years 2019 and 2024, has trained and should train approximately 46 thousand professionals per year, with a market demand of around 70 thousand professionals per year, as shown in Figure 3. There-

fore, if nothing is done and this scenario remains as planned, the area that depends on ICT professionals will have a deficit of approximately 260 thousand professionals.

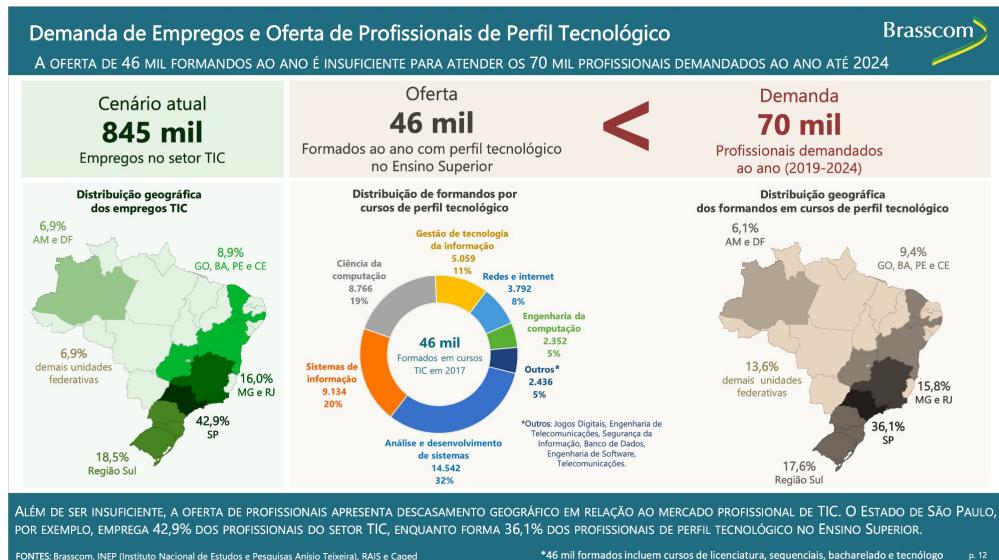


Figure 3. Demand for Jobs and Supply of Technological Profile Professionals.

Source: Gallindo, Sergio Paulo (2019). Educational Training and Employability in ICT Findings and Recommendations. Intelligence and Information Report BRI2-2019-010 v81. August, 2019. Retrieved on February 14, 2020 from <https://brasscom.org.br/estudo-brasscom-formacao-educacional-e-empregabilidade-em-tic-achados-e-recomendacoes/>

Still based on the research carried out by Gallindo (2019), in Brazil, in 2017, face-to-face courses in the ICT area offered 381,461 places between public and private universities and registered 785,687 enrollments, however, as can be seen in Figure 4, only 32% of vacancies are actually filled, only 10% graduate and only 5% are employed. It is important to note that the total number of vacancies is the sum of technological courses and bachelor's degrees in the country. Based on this

reality, it is possible to notice that Brazil needs to improve the training process, seeking a better use of the vacancies offered.

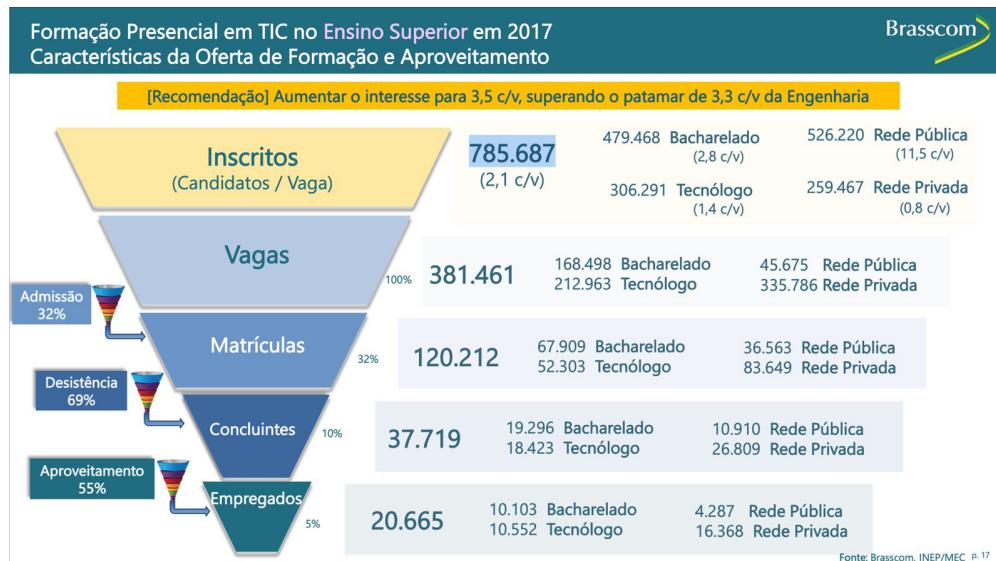


Figure 4. On-site training in ICT in higher education in 2017.

Source: Gallindo, Sergio Paulo (2019). Educational Training and Employability in ICT Findings and Recommendations. Intelligence and Information Report BRI2-2019-010 v81. August, 2019. Retrieved on February 14, 2020 from <https://brasscom.org.br/estudo-brasscom-formacao-educacional-e-empregabilidade-em-tic-achados-e-recomendacoes/>

According to a study by Boerhannoeddin et al.(2017) with companies in Malaysia, employee training proved to be more effective when working with the so-called *soft skills*, that is, social skills that allow professionals to obtain a better result in the company's daily routine. For example, salespeople who have ease for making friends usually have better results, as this skill helps you to perform your daily duties in the company.

It is possible to notice that the curricula of courses offered by universities are mostly based on technical/scientific training with a focus on the so-called *hard skills*, as they are professional skills that are easy to observe and measure, however, if the focus of teaching is only in this type of skills students/employees will be trained to perform task-oriented functions, without relationship and initiative skills (Boerhannoeddin et al., 2017). In addition, one of the problems observed in the workplace is the difficulty that many employees have in transferring the acquired knowledge to their daily work.

In this context, there is an initiative by some higher education institutions to make use of the Challenge Based Learning (CBL) methodology as a transformation tool (Nicholls, 2018; Santos et al., 2015). As presented in the previous section, CBL allows students to work on projects of personal interest and, together with the mentor, to learn concepts and develop attitudes and skills needed for the implementation of the solution found.

CBL, as a methodology based on documentation, reflection and sharing, allows those involved in research to work on real world problems, training their professional skills (*hard skills*), but also creates an environment conducive to the development of social skills (*soft skills*) (Johnson & Adams, 2011; Educase, 2012; Gibson et al., 2017).

When it comes to training students to develop applications, the use of CBL allows mentors to present situations that go beyond the code. Showing students of computing courses that the concern with the interface and usability are important technical items opens up a space that has not been much explored in this area before. As it is a real challenge,

students need, during all phases of CBL, to talk to their target audience and discuss with their colleagues before coding. In addition, at the end of the process, it is necessary to present the results to the world, another challenge that involves social skills (Educase, 2012).

CONCLUSION

An analysis of educational methods throughout history shows that creativity has been a characteristic that boosts teachers around the world in an attempt to create classes with deep and personalized meaning for their students, which causes a positive transformation in the individual journey of each student.

“Currently, many educators look after understanding and responding to the challenges of education considering only the elements of contemporary times. In a time of crisis and transformation, not only in the political and social spheres but also in the scientific and pedagogical spheres, the teaching processes aim to make learning possible for all. The multiplicity of subjects, knowledge, spaces and times cannot be secondary to school practices.” (Lancanalho et al., 2007)

Thinking about the present, considering the needs of current students is a rich and necessary practice for updating educational methods. However, in order to be able to draw a consistent future, it is necessary to analyze all the path that has been taken so far, retaining positive practices and learning from negative results.

Lancanalho et al. (2007) affirms that it is necessary, at first, to understand Didactics without marginalizing it from other contexts. Educational processes are the product of a series of contexts that range from socioeconomic and political transformations to the state of the art of technology.

Therefore, teaching-learning methods need to be analyzed from a historical perspective, in order to avoid prejudices and misconceptions about their real effectiveness. When educational practices focus on teaching in technology, another factor is added, which is training for the labor market. It is very important that students of higher education in technological courses or even undergraduate courses in the technological area, be trained so that they can, in industry or academia, continue to update the technology, once it is the target of their studies.

In this context, teaching practices are closely related to the organizational models of technology companies. The job market requires a very specific qualification from its future employees and requires the University to prepare the students for it.

The technology education journey therefore presents a transformation that aims to ensure that interpersonal relationships have meaning and produce artifacts that can be commercialized in the future. According to Kim (2018), the subjectivity of interrelationships between teachers and students promotes intentionality and conceptual significance, interfering in the teacher's performance in the classroom. Hence, it is clear that the educational methods have been updated in order to take the teacher out of the classroom and put him in a position of mentoring

the students' individual process and, along with it, the active methodologies look for student leadership.

When compared with the evolution of the organization of technology companies, it is possible to notice the connection of these educational techniques with the emergence of startups. According to Longhi (2011), startups are small companies usually set up at home or in college that receive small capital contributions. It is clear, therefore, that the coexistence of a business model centered on a small group of entrepreneurs and a theoretical and teacher-centered teaching methodology would be an unviable combination.

Since the end of the 90s and the beginning of the 2000s, both academia and industry have turned, then, to an action/learning model aimed at the individual and their relationships in a creative microenvironment that pursues to achieve a more visible and acceptance macro. Then, it is possible to note a cohesion between the active methods that seek space in the educational scenario and the creative business models that guarantee their acceptance in the industry.

Over the years, it was realized that the boom of startups would not be sustainable for a long time without a coherent organization and a good relationship with large companies. Likewise, active methodologies needed to be refined to balance the traditional content and the formation of skills for the 21st century professional. This journey then passed from its initial point of breaking barriers of traditionalism and seeks its normalization in the international context, ensuring the quality of students/professionals trained around the world.

REFERENCES

- Abio, G. & Stoyanova, Al. (2018). Applying Active Learning Methods in Higher Education. In Pérez-Marín, A., Daza-Pérez, L., & Alcañiz-Zanón, M. (Eds.), Teamwork, peer assessment and double revision of assignments as strategies for teaching quantitative research methods in Sociology. REIRE Revista d'Innovació i Recerca en Educació, 11(2), 126–137. Recuperado em 12 de fevereiro, 2020 de <http://doi.org/10.1344/reire2018.11.220569>
- Apple Inc. (2011). “Challenge Based Learning White Paper”. Recuperado em 03 de fevereiro, 2020 de
http://www.challengebasedlearning.org/public/admin/docs/CBL_Paper_October_2011.pdf
- Bergsteiner, H., Avery, G. C. & Neumann, R. (2010). Kolb's experiential learning model: critique from a modelling perspective. Studies in Continuing Education. Vol. 32, No. 1, pp. 29-46.
- Dewey, J. (1938). Experience & Education. The Kappa Delta Pi Lecture Series. Free Press: New York - NY.
- DMI Daily Digest. How to Bring Digital Transformation to Education. Recuperado em 14 de fevereiro, 2020 de <https://digitalmarketinginstitute.com/blog/how-to-bring-digital-transformation-to-education>
- Educause Learning Initiative. (2012). Things you should know about Challenge-Based Learning. Recuperado em 13 de fevereiro, 2020 de <http://educause.edu/eli>
- Gallindo, Sergio Paulo (2019). Formação Educacional e Empregabilidade em TIC Achados e Recomendações (Educational Training and Employability in ICT Findings and Recommendations). Relatório de Inteligência e Informação BRI2-2019-010 v81. Agosto 2019. Recuperado em 14 de fevereiro, 2020 de <https://brasscom.org.br/estudo-brasscom-formacao-educacional-e-empregabilidade-em-tic-achados-e-recomendacoes/>
- Gibson, D., Irving, L., & Scott, K. (2018). Technology enabled challenge-based learning in a global context. In M. Shonfeld, & D. Gibson (Eds.), Collaborative Learning in a Global World (pp. 25-40). (Literacy, Language and Learning). Charlotte, NC: Information Age Publishing.

- Henderson, S., Kinahan, M. & Rossiter, E. (2018). Problem-based learning as an authentic assessment method. PG Diploma in Practitioner Research Projects, DIT, 2018.
- Henry, L. A. & Lima, C. O. (2012). Promoting Global Citizenship through Intercultural Exchange Using Technology: The Travel Buddies Project. In Kelsey, S. & Amant, K. St. Computer Mediated Communication: Issues and Approaches in Education. Hershey, United States: Information Science Reference. Chapter 8, pp. 110-119.
- Johnson, L. & Adams, S. (2011). Challenge Based Learning: The Report from the Implementation Project. Austin, Texas: The New Media Consortium.
- Johnson, L. F., Smith, R S., Smythe, J. T. & Varon, R. K. (2009). Challenge-Based Learning: An Approach for Our Time. Austin: The New Media Consortium.
- Kim, L. (2018). Métodos ativos de ensino: coconstrução subjetiva da capacidade de pensar o próprio pensamento em sala de aula (Active teaching methods: subjective co-construction of the ability to think one's own thoughts in the classroom). Revista Brasileira de Psicodrama, v. 26, n. 1, pp. 31-40. São Paulo.
- Kolb, D. A. (1984). Experiential Learning: Experience as the Source of Learning and Development. Prentice Hall: New Jersey.
- Lancanalho, L. F.; Silva, S. S. C.; Oliveira, D. E. M. B.; Gasparin, J. L.; Teruya, T. (2007). Métodos de ensino e de aprendizagem: uma análise histórica e educacional do trabalho didático (Teaching and learning methods: a historical and educational analysis of didactic work). Atas do Evento. VII Jornada do Histedbr - O trabalho didático na história da educação. pp. 580-587. Campo Grande.
- Longhi, F. (2011) A história da revolução das startups (The history of the startup revolution). iMasters. Recuperado em 16 de fevereiro, 2020 de <https://imasters.com.br/carrera-dev/a-historia-da-revolucao-das-startups>
- Miettinen, R. (2000). The concept of experiential learning and John Dewey's theory of reflective thought and action. International Journal of Lifelong Education. Vol. 19, no. 1, pp. 54-72.
- Mochizuki, Y. & Bruillard, E. (Eds.). (2019). Rethinking Pedagogy. New Delhi: UNESCO MGIEP - Mahatma Gandhi Institute of Education for Peace and Sustainable Development (Report).

- Nicholls B. (2018). Challenge based learning: a real-world approach for secondary students to solve complex problems using geoscience knowledge and skills. *Terrae Didatica*, 14(4):369-372. Recuperado em 14 de fevereiro, 2020 de <http://www.ige.unicamp.br/terraedidatica/>
- Nichols, M., Cator, K., & Torres, M. (2016) Challenge Based Learner User Guide. Redwood City, CA: Digital Promise. Recuperado em 15 de fevereiro, 2020 de https://cbl.digitalpromise.org/wp-content/uploads/sites/7/2016/10/CBL_Guide2016.pdf
- Oliveira, J.A. (2016). The effectiveness of gamification as a problem-based learning tool on teaching agile project management. Thesis submitted to The University of Liverpool. DOI: 10.13140/RG.2.2.12016.66563
- Pacheco, B.A. & Souza-Concilio, I.A. (2014). Externalist Philosophy and Interaction: Proposal of Heuristics for the Design of Interactive Systems. Proceedings of Science and Information Conference. London, UK. DOI: 10.1109/SAI.2014.6918264
- Piaget, J. (1964). Part I: Cognitive development in children: Piaget development and learning. *Journal of Research in Science Teaching*. Vol. 2, pp. 176-186.
- Santos, A. R., Sales, A., Fernandes, P. & Nicholls, M. (2015). Combining Challenge-Based Learning and Scrum Framework for Mobile Application Development. *ITiCSE '15: Proceedings of the 2015 ACM Conference on Innovation and Technology in Computer Science Education*, pp. 189–194. Recuperado em 10 de fevereiro, 2020 de <https://doi.org/10.1145/2729094.2742602>
- Wan, G. & Gut, D. M. (2011). Bringing Schools into the 21st Century. Dordrecht, Netherlands: Springer.

CHAPTER 5

Educational digital tools to assist learning of people with intellectual disability

Denise Lemes Fernandes Neves

Silvana Maria Blacovi-Assis

Ana Grasielle Dionísio Corrêa

INTRODUCTION

Limitations in performing daily activities characterize the Intellectual Disability (ID) due to low intellectual functioning and the environment to which the individual, whether child or adult, is inserted (DSM-5, 2014). The American Association on Mental Retardation, in its 10th edition, proposes an ecological view of ID in which, dynamically, should relate to people, environment and available support systems (Dias & Oliveira, 2013). According to the American Psychiatric Association (APA), ID is characterized by a reduction in overall intellectual function, associated with limitations in, at least, one area of adaptive, conceptual, social and practical behavior, and should occur under the age of 18. Another way commonly used to classify the cognitive profile is to use measures of intelligence quotient, as follows: mild (IQ 50-70), moderate (IQ 35 to 50), severe (IQ 20 to 35) and profound (IQ less than 20).

For this group of people, limitations in practical, social and emotional skills can be found, besides a impairment to communication, self-care, social interaction, health and safety, which can permeate academic, leisure and/or work situations. However, possibilities to develop their potential using different strategies for learning) are real (Santos, 2012).

Digital and electronic games have been shown effective tools to assist in learning, encouraging playfulness and developing cognitive skills (Faria, 2019; Feurstein, 2014). Affordable digital games have interactive features that facilitate access for disabled users. Digital games are considered inducers of positive effects in the learning acquisition due to their playful nature (Vereeenooghe et al., 2016). However, more research is needed to sustain the adequacy of these games in order to train users with various disabilities (Börjesson et al., 2015; Britto & Pissaloto, 2016; Martins, Amato & Eliseo, 2018).

Throughout this chapter, some games are shown that may be important for cognitive support in the teaching and learning process of people with ID. A preliminary study, conducted with experts who serve people with ID, allowed eliciting requirements that must be prioritized in the digital games when they are for children with ID.

A preliminary survey showed that games developed in Brazil for children with ID tend to emphasize the teaching-learning process. However, their creators argue that such technologies may develop the cognitive functions, may help in memorizing and perception of users; in fact, there are not precise about potential characteristics that can be attributed to disability.

INTELLECTUAL DISABILITY

According to the American Association on Intellectual and Developmental Disabilities (AAIDD), Intellectual Disability (ID) is characterized as a limitation in performing daily activities due to intellectual functioning below the average of the population, limitation on adaptive behavior, which includes conceptualization skills (verbal and written language), and social practices, beginning under the age of 18. It is also characterized by a significantly reduced ability to understand new or complex information and to develop new skills (Guilhoto, 2011).

Cognitive impairment is characterized by a significant limitation of intellectual functioning and adaptive behavior before 18 years old. According to the Diagnostic and Statistical Manual of Mental Disorders (DSM-5, 2014), cognitive impairment can be classified into mild, moderate, severe and profound, depending on the gravity of the impairments. It occurs alone or associated with the presence of malformations/dysmorphic and affects about 1 to 3% of the population. The causes may be related to prenatal (genetic abnormalities, exposure to toxins or teratogenic, congenital infections, et so on), perinatal (prematurity, hypoxia, infection, trauma, intracranial hemorrhage, et so on) or postnatal (trauma, Central Nervous System (CNS) hemorrhage, intracranial infection, CNS tumor, et so on.). However, the etiology is only identified in about 50% of cases (Ribeiro & Freitas, 2019).

According to the World Health Organization (WHO, 2020), the health conditions (diseases, disorders, injuries, et so on.) are classified primarily in ICD-11, which uses the term “disorders of intellectual devel-

opment." In ICD-11, there are four subtypes: mild, moderate, severe and profound. It can also be classified as unspecified when there is evidence of cognitive impairment, but there is insufficient information to designate the category itself.

A breakthrough for disability issues in Brazil was the alteration of the medical model to the social model, which enlightens that the limiting factor is how the individual is located and not the disability itself, referring us to the International Classification Features (ICF). Such an approach makes it clear that the deficiencies do not, necessarily, indicate the presence of a disease or that the individual should be considered ill. Thus, the lack of access to goods and services should be addressed collectively and with structuring public policies for the equalization of opportunities (Convention on the Rights of Persons with Disabilities, 2010).

The Federal Government launched, in 2012, the "Live without limit" - National Plan of Rights of Persons with Disabilities – because of a firm political commitment to full citizenship of people with disabilities in Brazil (BRAZIL, 2020). Opportunities, rights and citizenship for all people are targets to which the Plan is dedicated to. Solutions in products and services are also encouraged by the Brazilian government, through fiscal and financial incentives for the development of products that help people with disabilities to improve their quality of life and provide them mobility and accessibility.

HOW IS ID DIAGNOSED?

According to Guilhoto (2011), ID causes are primarily organic as genetic disorders such as malfunction of a single gene, chromosomal abnormalities such as trisomy 21, among others; pregnancy problems induced by drug problems, by alcohol, by toxic, by viruses, by malnutrition of the fetus, among others; problems arising during delivery or in the first years of life (such as infections); diseases contracted in the first year of life, such as meningitis, lead exposure, continued ingestion of products containing lead, anemia due to iron deficiency. Guilhoto (2011) states that ID or cognitive delay is diagnosed by observing:

- a) the ability of the person's brain to learn, think, solve problems, to make sense of the world, a world intelligence around them (this ability is called cognitive functioning or intellectual functioning);
- b) necessary competence to live with autonomy and independence in the community in which one is inserted (this competence is also called adaptive behavior or adaptive functioning).

While the diagnosis of cognitive functioning is usually performed by qualified technicians (psychologists, neurologists, speech therapists, et so on.), the adaptive functioning should be object of observation and analysis by the family, by parents and by educators who are close to the child.

A field relevant to complement the assessment of children suspected of ID is the verification of emotional and behavioral problems. This check is widely used in the psychodiagnostic assessment of children and

adolescents with ID, but is not always used to support ratings of adaptive functioning indicators in social and practical domains. In Brazil, there are several instruments with adequate psychometric properties that evaluate these behavior problems, such as, Aberrant Behavior Checklist and Behavior Problems Inventory beyond ASEBA inventories (Teixeira et al., 2018).

Clinically, the ID can be classified as mild, moderate, severe and profound, and these defined levels are primarily based on adaptive functioning and not necessarily in psychometric tests, which may be insufficient for reasoning assessment in real-life situations and domaining of practical tasks (APA, 2014).

To diagnose ID, professionals study the mental abilities of the individual and its adaptive skills. These two aspects are part of the definition of typical cognitive delay to most scientists who are dedicated to the study of ID.

ID COGNITIVE IMPAIRMENT

According to Feurstein (2014) and Britto & Freitas (2019), cognitive development is widely linked to human development for learning in educational contexts and other skills throughout life. The authors state that it is possible the cognitive development, but some barriers may hinder the people development with moderate and severe commitment, they are:

- a) Etiological barrier: the cause of deficits or dysfunction. The etiology term refers to a wide variety of causes. Some of these causes are organic and originate in human biological structure, and they are con-

sidered responsible for malfunctioning (including many cognitive by nature). It is assumed that these barriers were invincible obstacles, and that brain damage was irreparable.

- b) Age barrier: age at which the barrier has been identified and the intervention started. It was believed that if a person did not reach certain functions, for example, the development of language, reading, or forward-thinking functions, until a certain age, the skill needed for adaptation and the behaviors that will enable the operation are unlikely to be modified. The option given to humans to develop themselves was limited by time and “if time went by”, there would be more possibilities to change. There is a natural acceptance in the decline of skills or limited potential of changes in the functions after the passage of the critical period. Human beings are modifiable throughout their lives. It extends beyond purely physiological developments.
- c) Barrier produced by the severity of the individual condition. There are severe multiple disabilities - physical, sensory and mental - that question the changeability of a person. There are reports of many cases where people with severe disabilities have developed skills such as reading, writing and using the computer. This means we can no longer be satisfied with theoretical assumptions about changeability. There must be a willingness to overcome barriers and then the change option can be realized and can become a reality.

The most severe impairments in physical, sensory and mental conditions may hinder the chances of the transformation of a person. However, we can not say for sure that this is impossible. We can not be content

with theoretical assumptions, because as Feuerstein (2014), it is also required a need, an involvement and a commitment to help the other to achieve a quality of life, and this mediation, will make all the difference in the development of the individual in these conditions.

ID TREATMENT

According to Guilhoto (2011), there are not drugs that promote “the healing” of the ID, but medications are often used for conditions that may or may not be associated, such as epileptic seizures, or psychiatric disorders such as depression, anxiety, psychosis and behavior changes that compromise the individual integration into family and society.

Stimulation proposal from techniques accepted by the child is carried out for the development of specific functions that are outdated in children affected by the disability (Rodrigues, 2009). Thus, after an initial assessment that determines the time of development in which the child is, both the child's needs and the program in which he must be submitted are settled.

Professionals with different backgrounds can contribute and should participate in treatment, depending on the degree of impairment, of damages and of the goals that were set for enhancing the development. The sooner an intervention is started, the better the prognosis. In different phases of a person living with ID, the participation of physiotherapists, occupational therapists, speech therapists, doctors of various specialties, psychologists, educators and/or other professionals may be relevant (Schwartzman & Lederman, 2017).

ID PEOPLE WITH LEARNING DISABILITIES

As Rodrigues (2009), students who have trouble in concentrating need an organized space, routine, logical activities and rules. There are three main problems: lack of concentration, barriers in communication and interaction, and less capacity to understand the logic of the operation of the language as they do not understand the written representation or require a different learning system. Ideally, the activities have a practical and instrumental beginning. It is also essential to adapt the proposal to the biological age of the person, using for an adult fewer children's themes. The task must start as easy as it is necessary to realize that he can run it, but always with some challenge.

In addition to the problems faced by the person with cognitive issues, there are physical issues that, when they take part in the diagnosis, they also influence the learning process. Blascovi-Assis et al. (2018) present studies that evaluate the motor characteristics of people with Down Syndrome (DS) and report significant motor changes. However, the causes of this finding may be related to some peculiarities presented in the syndrome, such as the anatomy of the hand, which are small and thick, with short fingers, which can lead to differentiation in manipulative functions and affect grip strength. The DS is a genetic change that occurs at conception in chromosome cells. There is no scientific explanation for why this change occurs, but the limitations imposed by this syndrome are known and include motor, sensory and cognitive/intellectual difficulties.

In another study by Neves (2019), on the use of digital tools, time-use activities with digital tools can lead to fatigue, just by the physical

and the mental effort that people with ID need to provide for carrying out tasks lasting more than an hour.

DIGITAL EDUCATIONAL TOOLS FOR ID PEOPLE

New technological features favor the functional development of people with disabilities, such as assistive technologies (Vereeenooghe et al., 2016; Rose et al., 2005). Some of the assistive technologies that people with disabilities use in different activities in their daily lives are: computers, tablets, mobile devices, electric or manual wheelchairs, canes, walkers, screen readers, hearing aids, among others. Some of these features can help people diagnosed with ID to access to digital information, such as communication boards, screen readers and voice commands (Vereeenooghe et al., 2016).

People with ID forget the concepts very quickly and the learning process becomes complicated, making the use of teaching-learning applications useful to help the process of literacy and development of some cognitive abilities such as memory and laterality. In this context, digital games, have proven practical tools to assist learning, to stimulate playfulness and to the development of motor and cognitive abilities (Vereeenooghe et al., 2016; De Paula et al., 2016). Digital games are considered to have positive effects of inducing the acquisition of learning because of its playful and involving nature. However, more research is needed to sustain the adequacy of these games to train people with learning ID (Börjesson et al., 2015; Britto & Pissolato, 2016; Martins et al., 2018).

Although there are few applications developed specifically for people with ID, digital games are essential tools to assist the teaching and learning process and developing cognitive skills. A digital game developed to assist the process of literacy of a typical child, for example, can be used by an atypical child since the proposal of the game is accessible to him.

Whereas the subject with intellectual diversity presents difficulties in assimilating abstract content, it is necessary to use concrete learning materials, and of methodological strategies for this student to develop his cognitive skills and to facilitate his knowledge construction (Martins et al., 2018).

INTERVIEWS WITH ID EXPERTS

In an exploratory survey conducted by Neves (2016), interviews were conducted with five health professionals work with people with ID, aiming to identify important features related to digital tools, specifically for this population. Below the main parts of the reports of these interviews are highlighted.

A) Occupational Therapist: one tool developed specifically for this audience should consider some specifics learn mode in these people, such as slower pace of understanding and establishing cognitive relations among the available information, lower readiness in response, learning generalization difficulties. It is essential to provide a large number of different situations involving the same cognitive skills that are being stimulated.

B) Medical coordinator from an institution serving people with ID: technological resources can be tailored to a specific individual or group difficulties because even these individuals having a slower development, similar in some steps to younger people, there is often a disparity in the difficult levels, for example, increased either in the visual-constructive sphere, or memory, or abstraction, or coordination, and so on.

C) Speech Therapists: considering the low investment in research and studies focusing on ID; the digital tools, are mostly developed for people without disabilities, and may or may not be used with people with ID. However, it is essential to consider that the tools must meet the prospect of universal design, currently valued. This approach consists of stimulating the construction of resources, materials, instruments that may be used by many different groups with or without disabilities. Thus, these tools have a broad usage profile in assisting from the typical population to those with physical, sensory, intellectual disabilities, among others. This is possible since that it depends on careful observation on the need for possible adaptations (for example, for proper use of the mouse for possible fine motor disability) aiming to use the tool in its entirety. Another essential aspect of being considered is still in the attention to concrete and abstract aspects of the selected content to compose the tool. Too much abstract content may hinder the understanding, by the user with ID, of what we expect him to do, the activity goals, the achieved targets. The focus on more concrete aspects, with closer everyday situations of these users, increases the chances of achieving positive results.

D) Speech Therapists: a tool with more playfulness, like letters and appropriate images, would help to develop and to work skills that are more difficult for the ID public to understand and to assimilate.

E) Pedagogue: digital games are possible and necessary, since most of the proposed activities in popular games for any public, lead special people to frustrate themselves for, in a given situation, even not understanding what they are asked to do. Interestingly, it should be a tool directed to a particular audience, and, in that, the language, the speech, and the results should be consistent with the cognitive skills of people with ID.

Within the needs presented by the experts, there are applications and games for people with ID. Some of the features presented were included as requirements in the development of the software presented below.

REQUIREMENTS OF GAMES AND APPLICATIONS FOR ID

Based on interviews with experts on the development of games for people with ID, the following characteristics were identified:

To present a slower pace when presenting the game information;

To offer lower readiness in response;

To contain some different situations to train similar skills;

To allow adaptation of difficulty levels;

To allow adaptation of different interaction devices (mouse, keyboard et so on);

To present concepts and playful situations closer to daily life.

EDUCATIONAL DIGITAL TOOLS WITH POTENTIAL FOR PEOPLE WITH ID

Some digital educational tools found on a search based on the requirements presented, have the potential of being used with people with ID. The digital games are presented below. However, there are no reports of scientific evidence that the technologies presented helped in the cognitive development of the people who used them, particularly people with an ID diagnosis.

Jecripe

Jecripe (Figure 1) is a game created to serve children with ID. The Jecripe activities are progressive and stimulate perception, logic and motor skills of children in actions such as moving, clicking and dragging objects with the mouse. The Jecripe brings an intent of imitation of what makes the main character, Betinho, which has features of a child with DS, to increase the identification with the player.



Figure 1. Jecripe game screens

Source: <https://jecripe.wordpress.com/>

Cognitive skills stimulated by the Jecripe game are divided into four different activities: a) beach view from the window for training memo-

ry and attention; b) beach bag for training attention; c) sand beach for working the attention and phonological awareness; d) aunt Ina ranch for working memory, attention and phonological awareness.

Sacdi

Sacdi (Figure 2) is an educational application developed by researchers from the University of Rio Grande do Norte, with the aim of helping the process of literacy of children with intellectual disabilities, especially children served in multifunctional resource rooms in schools.



Figura 2. Screens of the App Sacdi

Source: Paradeda & Silva (2013)

The application offers two options after the login screen: the student and the teacher. In the Student option, after selecting the “Literacy” button, the user starts literacy activities. In the example in figure 2, two activities that work with letters and syllables were made available. The activity called “What letter do you start with?”, Presents a figure and the word corresponding to this figure without the first letter, where the user must choose among the options the letter that completes the word.

Papado

Papado (Figure 3) is an educational software created by the Center for Education and Culture of the Federal University of Amapá. The software uses resources and services of assistive technologies, aimed at children with DS. It emerges as an educational tool for promoting the learning of the child for the 1st grade of elementary school through symmetry, colors, figures, ordinality, set, quantity, addition and subtraction features.

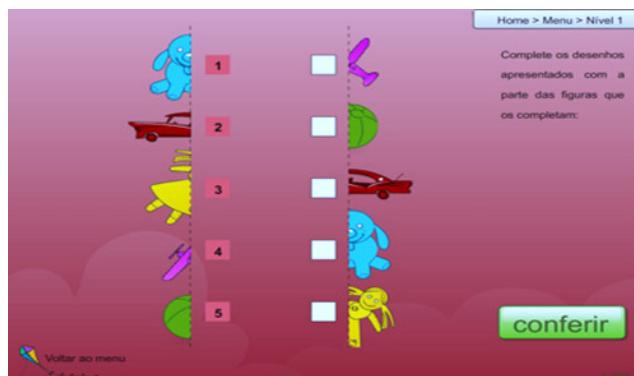


Figure 3. Papado game scre

Source: <http://educacaoinclusiva-entic-ufal.blogspot.com/2014/11/software-educacional-papado-o-software.html>

The development of this educational software was made based on the usual activities performed by teachers with students in their classrooms. The software has computer screens rather simple, like figures, colors and shapes that emphasize a playful intent to encourage the development of logical-mathematical reasoning and decision-making through the multimedia resources, which enables children to acquire knowledge in a fun and interactive way.

My ABC Down

“My ABC DOWN” (Figure 4) is an application for the Android mobile platform. The application assists in literacy and alphabetization processes aimed at reducing the impact imposed by disability, taking into account the specificities of this target audience for both the characterization tool and the definition of its functionality. The application “My ABC DOWN” allows you to associate the letters with audio (sounds produced by children), images (captured by the children for the tablet’s camera) and the corresponding text to the name of the “object”. It has also games to improve exercise memory and motor coordination.



Figure 4. My ABC DOWN game screens

Source: <https://repositorio.ufpb.br/jspui/handle/123456789/3354>

The keyboard is more extensive (to accommodate mobility limitations) than the common one, has sound for all keys (to stimulate speech and language) and follows the alphabetical order ABCDEF (suitable for the literacy period), it does not offer the QWERTY format, common in tablets. All these requirements are taken as the application differential, compared to games already presented, as there are features that are best suited to the accessibility difficulties of a person with DS.

Participar 2

Participar 2 (Figure 5) is a tool to support the teacher in the student literacy process with people with ID. It collaborates with digital inclusion as it brings the ID student closer to a computer.

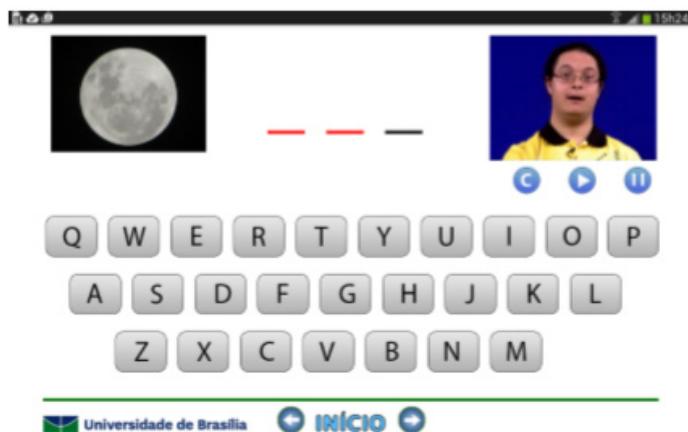


Figure 5. Participar 2 game screens

Source: Costa (2015)

The objective of the Participar 2 game is to make the student have greater comfortability with technology, using the program. The more technology is used as a literacy tool, the more the concept of digital inclusion is gaining space so that the technology learning process will be natural.

FINAL CONSIDERATIONS

If the person with diversity knows very little about the skills from those people who have no limitations, the opposite is also a reality. The behavior and physical and cognitive abilities of an individual diagnosed with Down Syndrome or Autism are different from the individual's behavior diagnosed with Fragile-X syndrome, for example. Besides the features of the disorders and syndrome diagnosis, there is also the assessment of cognitive impairment. People diagnosed with ID with mild impairment can interact with games that are designed for typical people without disabilities. Adults with mild impairment, even if they are not literate, can interact with games that are intuitive and have a good GUI (graphical user interface). The biological age (children and adults) should also be taken into account, as adolescents and adults with mild impairment do not appreciate infantilized games.

There is a significant evolution in the development of tools for accessibility, such as screen readers and voice synthesizers for people with disabilities, software in sign language for deaf and adaptive software for disabled people. On the other hand, there are still segments, such as ID, where there were not found references and studies related to the use of technology to evidence in the assistance to cognitive development, but a stimulus. Therefore, it is common the applications are being used by people with disabilities, even the software is not explicitly designed for them, especially in the teaching-learning approach.

Creating *software* for people with special needs still requires further research for the limitations understanding and impact, user experienc-

es and studies of interaction design, applying concepts of usability and accessibility. Taking out all the barriers imposed by disability, the learning content should be presented by the digital tool, being for software engineers and software manufacturers the same challenge faced by a teacher, who seeks appropriate methodologies in a classroom where the limitations of disability are the main barriers to the teaching-learning process.

REFERENCES

- American Psychiatry Association - APA (2014). Diagnostic and statistical manual of mental disorders, fifth edition: DSM-V. Washington DC: APA; 2014.
- Blascovi-Assis, S.M.; Quinta, R.H.R.; Quedas; C. L.; Angelico, S.S.A.; Souza; A.B (2018). Destreza manual em pessoas com Transtorno do Espectro do Autismo e Síndrome de Down: características e instrumentos de avaliação referenciados na literatura (Manual dexterity in people with Autism Spectrum Disorder and Down Syndrome: characteristics and assessment tools referenced in the literature). In: Distúrbios do desenvolvimento: estudos interdisciplinares. (Org.) Cibelle Albuquerque de la Higuera Amato, Decio Brunoni, Paulo Sérgio Boggio. São Paulo: Memnon. Pg. 381-389.
- Börjesson, P.; Barendregt, W.; Eriksson, E. (2015) Designing technology for and with developmentally diverse children - A Systematic Literature Review. Proceedings of the 14th International Conference on Interaction Design and Children - IDC. Boston, Massachusetts, USA.
- Brasil. Secretaria Nacional de Promoção dos Direitos da Pessoa com Deficiência – SNPD (2009) (National Secretariat for the Promotion of the Rights of Persons with Disabilities). Disponível em: <<http://www.pessoacomdeficiencia.gov.br/app/publicacoes/tecnologia-assistiva>> Acesso em: 06 fev, 2020.
- Britto, T.C.P.; Pizzolato, E. (2016) Gaia: uma proposta de um guia de recomendações de acessibilidade de interfaces web com foco em aspectos do autismo (Gaia: a proposal for a guide for recommendations on accessibility of web interfaces focusing on aspects of autism). V Congresso Brasileiro de Informática na Educação (CBIE), 24 outubro, Uberlândia, MG, Brasil.

Convenção sobre os Direitos das Pessoas com Deficiência: Protocolo Facultativo à Decreto Legislativo nº 186, de 09 de julho de 2008:Decreto nº 6.949, de 25 de agosto de 2009.4^a Ed., rev. e atual. Brasília: Secretaria de Direitos Humanos, 2010.

De Paula, B.H.; Valente, J.A.; Hildebrand, H.R. (2016) Criar para aprender: Discutindo o potencial da criação de jogos digitais como estratégia educacional (Create to learn: Discussing the potential of creating digital games as an educational strategy). *Tecnologia Educacional*, 54(212), 6-18.

Dias, S.S. & Oliveira, M.C.S.L. (2013). Deficiência intelectual na perspectiva histórico-cultural: contribuições ao estudo do desenvolvimento adulto (Intellectual disability in the historical-cultural perspective: contributions to the study of adult development). *Revista Brasileira de Educação Especial*, 19(2), 169-182.

DSM-5. Manual diagnóstico e estatístico de transtornos mentais: DSM-5 (2014) [American Psychiatric Association; tradução Maria Inês Corrêa Nascimento...et al.]; revisão técnica: Aristides Volpato Cordioli... [et, al] (5^a ed.). Porto Alegre: Artmed.

Faria, L.C.F. (2019) O jogo eletrônico no desenvolvimento da percepção musical (The electronic game in the development of musical perception). *Techno.exe*, Volume 1. Fabiana Martins, Sérgio Basbaum (organizadores), São Paulo: Pontocom, 239-249.

Feurstein, R. (2014) Além da inteligência: aprendizagem mediada e a capacidade de mudança do cérebro (Beyond intelligence: mediated learning and the brain's ability to change). Rafael S. F.; Louis H. F.; prefácio de John D. Bransford; tradução de Aline Kaehler. Petrópolis, RJ: Vozes.

Guilhoto, L.M.F. (2011) Aspectos biológicos da deficiência intelectual (Biological aspects of intellectual disability). REVISTA DI, julho/dez. 2011. Disponível em: <<http://www.apaesp.org.br/instituto/Paginas/Revista%20DI.aspx>>. Acesso em: 13 fev, 2020.

Martins, V. F.; Amato, C. A. H.; Eliseo, M.A. (2018) Desafios para o desenvolvimento de aplicações computacionais para o contexto de Distúrbios do Desenvolvimento (Challenges for the development of computational applications in the context of Developmental Disorders). In: Distúrbios do desenvolvimento: estudos interdisciplinares. (Org.) Cibelle Albuquerque de la Higuera Amato, Decio Brunoni, Paulo Sérgio Boggio. São Paulo: Memnon, 2018.

Neves, D.L.F. (2016) Um estudo de requisitos no desenvolvimento de software para a diversidade intelectual (A study of requirements in software development for intellectual diversity). Dissertação de Mestrado, Pontifícia Universidade Católica de São Paulo, SP, Brasil.

Neves, D.L.F. (2019) O uso da tecnologia no desenvolvimento cognitivo de pessoas com diversidades (The use of technology in the cognitive development of people with diversity). Techno.exe, Volume 1. Fabiana Martins, Sérgio Basbaum (organizadores), São Paulo: Pontocom, 297-316

Rodrigues, C. (2009) Formas criativas para estimular a mente de alunos com deficiência (Creative ways to stimulate the minds of students with disabilities). Revista Nova Escola. Disponível em: <https://novaescola.org.br/conteudo/440/formas-criativas-estimular-mente-deficientes-intelectuais>. Acesso em: 23 fev, 2020.

Rose, D.H.; Hasselbring, T.S.; Stahl, S.; Zabala, J. (2005). Assistive technology and universal design for learning: two sides of the same coin In: D. Edyburn, K. Higgins, & R. Boone (Eds.), Handbook of special education technology research and practice. Whitefish Bay: WI: Knowledge by Design.

Santos, D.C.O. (2012). Potenciais dificuldades e facilidades na educação de alunos com deficiência intelectual (Potential difficulties and facilities in the education of students with intellectual disabilities). Educação e Pesquisa, 38(4), 935-948.

Schwartzman, J.S. & Lederman, V.R.G. (2017). Deficiência intelectual: Causas e importância do diagnóstico e intervenção precoces (Intellectual disability: Causes and importance of early diagnosis and intervention). Inclusão Social, 10(2), 17-27.

Teixeira, M.C.T.V.; Tafla, T.L.; Santos, A.P.; Carrero, L.R.R. (2018) Deficiência intelectual: contribuições para sua identificação e avaliação (Intellectual disability: contributions to identification and evaluation). In: Distúrbios do desenvolvimento: estudos interdisciplinares. (Org.) Cibelle Albuquerque de la Higuera Amato, Decio Brunoni, Paulo Sérgio Boggio. São Paulo: Memnon.

Vereeenooghe, L.; Gega, L.; Reynolds, S.; Langdon, P. (2016) Using computers to teach people with intellectual disabilities to perform some of the tasks used within cognitive behavioural therapy: A randomised experiment. In: Behaviour Research and Therapy, (1):76, 13-23.

CHAPTER 6

A model for evaluation of students' neurobehavioral complaints in school context

Naími Moreira Nobre Leite

Vander Pereira da Silva

Camilo Ernesto Subenko Olalla

Maria Teresa Carthery-Goulart

Katerina Lukasova

INTRODUCTION

Language development accompanies and interacts with a series of cognitive changes in an interdependent relationship. Working memory (WM) is a system involved in the temporary storage and manipulation of verbal and non-verbal information and its functioning is closely related to language development at different levels such as vocabulary acquisition, foreign language learning, comprehension of sentences and texts and learning to read and write. In this chapter, we aim to present the technique of functional near-infrared spectroscopy (fNIRS) as a potential tool to identify neural correlates of WM development in children aged 7 to 11 years at different stages of the literacy acquisition. We organized the chapter into four sections: in the first, we present the phases of acquisition of reading and writing in typical development and an overview of how the characteristics of the Portuguese writing system influences

learning of reading and writing by children; in the second, we introduce the concept of WM and its relationship with the development of oral and written language; next, we present the neural correlates of this system from structural and functional magnetic resonance studies and in the last, our experience in the use of functional near-infrared spectroscopy to evaluate WM, as well as the advantages of this neuroimaging technique for studies in scholars.

CHARACTERISTICS OF WRITING SYSTEMS AND PHASES OF DEVELOPMENT OF READING AND SPELLING

It is known that writing systems have an influence on reading. We have systems in which graphic symbols (graphemes or characters) represent words or concepts (logographic systems), others in which such symbols represent syllables (syllabary) and, finally, those in which graphemes represent phonemes, such as the alphabetical system. In the alphabetical system there is also great variation between languages, with more regular, or transparente, systems, such as Portuguese, and more irregular ones, with more ambiguities and exceptions, such as English. Graphemes are graphical representations of language's phonemes, while phonemes are the smallest units of sound capable of distinguishing between meanings in a language: for example, <foca> and <toca> have different meanings in Portuguese depending on the distinction marked by the phonemes <t> and <f>. Graphemes do not correspond to letters, since we can have a set of letters representing a single phoneme. This means, for instance, that in <bola> we have 4 graphemes (representing 4 phonemes) and 4 letters,

on the other hand in <carro> we have 5 letters and only 4 graphemes and 4 phonemes (“rr” represents a single grapheme / phoneme). In this sense, when a system is more transparent in his word’s phonology, the regularity in the grapheme-phoneme conversion is greater, while, in less transparent systems, this conversion is less regular.

A word is considered irregular for reading when, through the application of conversion rules, we are unable to come up with a single pronunciation, as in <táxi> and <tóxico>. We say that Portuguese is a system of medium transparency for reading because we have only three situations in which the application of conversion rules can generate different phonological representations: the phonemes represented by the graphemes <e> and <o> in paroxytonic words, which can have different pronunciations (E.g.: <mescla> vs <mesmo>; <foca> vs <fogo>) and the grapheme <x> that can represent different phonemes (E.g.: <exame> vs <máximo> vs <táxi> vs <enxurrada>). Another important feature of Portuguese is the simpler syllabic structure, compared to other systems such as English. These considerations about writing systems are relevant since lower transparency for phonology and greater syllabic complexity mean a slower acquisition of reading and writing by children (Seymour, Aro, & Erskine, 2003).

The reader, when faced with a word never read, may use some strategies, such as decoding, analogy or prediction to read it. In decoding, he uses his knowledge of an orthographic system to convert graphemes into phonemes and to unite them in a familiar way. When using analogy, the reader searches for known patterns in the unknown word, as in <trilha>

recognizing <ilha> and from there, combine the pronunciation of the known word, with the phonemes represented by the remaining graphemes to be able to pronounce the word. In the prediction strategy, the reader uses the context, figures, close words in the sentence and part of the known letters to predict the unknown word. However, by storing the pronunciation of words in long-term memory, children start to recognize these words automatically, accessing their pronunciation and meaning, as long as they have practiced enough. As a result, the decoding strategies mentioned start to be in the background, being used only when the child is faced with a new word or a word read with less frequently. In this phase of the reading acquisition process, when there is more fluency and automaticity for word recognition, there is a progressive decrease in the cognitive effort for reading, since, instead of individual graphemes, the reader starts to identify words as whole elements. This ability to read automatically by accessing long-term memory makes reading more fluid, besides providing a focus on the meaning of the text and not on the decoding of each word (Pollatsek & Treiman, 2015).

However, this type of more dynamic reading occurs only in more experienced readers, since the child at the beginning of the literacy process needs individual grapheme-phoneme decoding. Children's progress in reading development is explained by the four-phase theory proposed by Ehri (2005): pre alphabetic, partial alphabetic, full alphabetic and consolidated alphabetic. These phases reflect the child's level of knowledge of grapheme-phoneme conversion, using memory and gradually moving from the least elaborated to the most sophisticated. In the initial

pre alphabetic phase, the child deals with words like drawings or images, memorizing their meaning from the pictorial visual elements. In the next phase, the partial alphabetic, the child begins to associate letters with sounds and to make the conversion in a limited way. As it progresses and reaches the full alphabetic phase, this conversion becomes a familiar tool, but reading still occurs imperfectly, especially in irregular words. Finally, upon reaching the consolidated alphabetic phase, conversions become fluent and intensified, including syllables and morphemes (the smallest linguistic unit with meaning). During each of these phases, regardless of chronological or school age, strategies vary as the child's automation and orthographic knowledge progress (Pollatsek & Treiman, 2015).

With regard to writing, this task can be more complex than reading (Mommers, 1987), it's acquired later, in part due to the need for some prerequisites, such as having the spelling of the whole word in memory, having mastery of graph-phoneme conversion rules and have resources in WM to maintain the sequence of graphemes and letters, until its graphic production is complete, which is a slower process than the visual processing required for reading. As we mentioned for reading, transparency for phonology has considerable relevance in many languages, since the correspondence between the written form and the sound can vary between languages. The spelling brings information about the origins of words (influence of one language in another) and the oral language changes more quickly than the written one, which can generate more ambiguities and irregularities. In this sense, the child needs to realize

that the act of writing implies not only conversion, but also access to long-term memory to resolve ambiguities (Pollatsek & Treiman, 2015).

Despite some variations, there are also stages of development of writing, analogous to those of reading. According to Ehri (1997), in the first phase, the pre-phonologic, the child understands that words are made of letters, but the letters chosen may not be related to the pronunciation of the word, such as writing <ABTOPM> for the word <GIRAFFA>. As more alphabetic knowledge is acquired, the child begins to understand that, in addition to being formed by letters, written words represent spoken words, and that, thus, letters form the sounds that make up those words. This moment marks the partial alphabetic stage, or semi phonetic stage, in which the letter-sound conversion is still incomplete, and the child can write strings such as <GRF> to <GIRAFFA>, representing just some of the phonemes of the word. Then the child starts to produce more elaborate words reaching the full alphabetic or phonetic stage, in which the word <GIRAFFA> can now be spelled <JIRAFFA>, expressing the phonemes through graphemes in a way closer to the correct spelling and demonstrating the child's effort to represent his knowledge of letters and the way he hears words. When advancing and overcoming phonological principles, the consolidated alphabetical phase represents the knowledge of the structure of words, prefixes, suffixes, silent letters etc.

The success in reaching the advanced stages makes the child a competent reader and writer and encompasses a series of cognitive changes related not only to language processing, awareness of phonological representations and formation of orthographic lexicons (memory of words

written for global reading and for written production), but also in memory systems and executive functions, since the increase in efficiency in these systems is closely related to language development. The acquisition of reading and writing requires efficiency of the memory systems just as literacy also shapes and promotes the development of memory, mainly of verbal WM (Demoulin & Kolinsky, 2016).

THE WORKING MEMORY AND ITS RELATIONSHIP WITH LANGUAGE AND ACQUISITION OF READING AND WRITING

WM has been conceptualized in several theoretical and experimental models (for a review on the various models, see Miyake & Shah, 1999), but one of the most cited models in the literature is the multiple component model by Baddeley and Hitch (1974), Baddeley (2010). The multiple component model proposes the existence of several domain-specific “slave” subsystems responsible for the temporary storage (in the order of a few seconds) of limited amounts of information (phonological, visuospatial and multimodal) that are controlled by the central executive, a limited system in terms of attention that selects and manipulates the material stored in these subsystems, serving as a attentional controller or manager that commands the entire system (Baddeley, 2015; Gathercole, 1999). One of the “slave” components is called a phonological loop and is responsible for the temporary storage of acoustic sequences or speech-based items (Baddeley, 2015). The phonological loop is assumed to have two subcomponents, a short-term memory storage (phonological buffer), and an articulatory rehearsal process that can be performed

openly (out loud) or covertly (subvocal) (Baddeley, 2015). Storage is assumed to have limited capacity, with items recorded as memory traces decaying within a few seconds (Baddeley, 2015). However, the traces can be kept longer by the rehearsal, i.e., telling the items to themselves, which depends on a vocal or subvocal articulatory process (Baddeley, 2015).

Studies have shown that phonological loop performance can be impaired by two widely investigated factors: the effect of phonological similarity and the effect of word length. The similarity effect corresponds to a worse performance when the words are phonologically similar (for example, memorizing in sequence items such as < eight, great, weigh, wait > is more complex than when the words are phonologically different, such as the sequence < cap, school, ceiling, mild >. The other effect that can impair the performance of the phonological loop is the length of the word. This effect is defined by the finding that the memory capacity is lower for words which take longer to be spoken than for those that take less time (Eysenck & Keane, 2010).

As a slave system, phonological WM is well documented as a cognitive ability that mediates the total variation related to performance in various complex cognitive activities, such as reasoning, learning, mathematical calculations, reading and writing comprehension (Baddeley, 2015; Park et al., 2002). Some researchers (Baddeley, 2015) have drawn attention to the fact that the phonological loop plays an important role in controlling action. According to Baddeley (2015), it can be noted that participants in psychological experiments very often seem to rely on ver-

bal coding in order to perform the task, basing themselves on a subvocal set of instructions to maintain their positions, demonstrating support in verbal coding.

In children that are learning how to read and write, studies have found relationships between phonological WM skills and speech and language skills (Grivol & Hage, 2011). Phonological WM processes are important for the acquisition of literacy because phonological information needs to be recorded in WM and thus transferred to the long-term in order to result in the development of oral and written language (Cardoso, Silva, & Pereira, 2013). Researchers have found evidence that advocates a prominent role in reading acquisition in verbal WM (Demoulin & Kolinsky, 2016). According to these researchers, initial decoding activities may reinforce the development of the subvocal essay, which in turn would improve performance in serial order in short-term memory tasks of immediate recall. Another fact cited by Demoulin and Kolinsky (2016) is that learning to read and write in an alphabetic system allows the emergence of phonemic consciousness, refined phonological representations and orthographic representations. These processes can improve the quality, strength and accuracy of lexical representations and consequently provide better support for temporary coding of memory items and/or their recall (Demoulin & Kolinsky, 2016). This data is also found for the acquisition of written language, and the phonological information, once detected, is stored in WM and later transferred to the long-term, thus allowing the learning of the phoneme-grapheme association (Cardoso, Silva & Pereira, 2013). Several studies have shown an

increase in the performance of phonological WM (Cowan, Li, Glass, & Saults, 2017; Gathercole, 1999), i.e., during childhood development children with 4 years have a small capacity to store speech-based items, an increase being observed at 6-8 years, with a smaller increase at 10-13 years, which is no different from adults (Cowan et al., 2017).

The multi-component model of WM presents a broad and complex cognitive framework, in which each component presents its specific domain and interacts with the other components of this system. In the phonological loop, the hearing information is stored in the phonological short-term storage system and can follow two probable routes: one is to go to the phonological output buffer (speech programming), and the other route would be through the reverberation process (making the information return to the storage system) (Lobo, Acrani, & Ávila, 2008). This component allows hearing and/or speech-based information to be coded, stored, reverberated and manipulated by the subject, processes that are of paramount importance for the use and understanding of language. Phonological WM is a construct that has accumulated a large amount of experimental evidence from typical developing adult and child participants as well as patients with cognitive dysfunctions (Baddeley, Gathercole, & Papagno, 1998) that demonstrate the relationship of this ability with: vocabulary acquisition, word learning, phonological storage, spoken language structure (both for immediate memory performance and vocabulary acquisition), providing highly flexible language learning (Baddeley et al., 1998).

NEURAL CORRELATES OF WORKING MEMORY

Regarding the neural correlates, it is important to understand that by keeping information active, WM supports recognition of the stimuli specific patterns and interacts with long-term memory. Let's take as an example sentence reading, which can be seen as a decoding of an array of words organized in a serial order. The sentence comprehension requires a temporary storage of the words meanings and the sequential relationship between them. The processing of phonemes sequence or larger units, such as syllables, also requires temporary storage, but for an experienced reader the phonological information is represented at the lexical-semantic level (whole words) that is readily evoked from the long-term memory. The transition between WM and the long-term memory occurs whenever there is recognition of phonotactic, lexical and / or semantic patterns and regularities. Therefore, patterns can emerge in different tasks, such as memorizing pseudowords with familiar orthographic structure, arrays of digits, word lists, etc. In these tasks, better performance, shorter reaction times and reduced neural activation have been reported (Eriksson, Vogel, Lansner, Bergström, & Nyberg, 2015).

In adults, functional Magnetic Resonance Imaging (fMRI) studies assessed neural activation in WM and reported a network of neural regions with different activation patterns. Tasks requiring verbal WM activated the middle and inferior temporal gyrus for processing of lexical-semantic information and the superior temporal gyrus for sub lexical phonological representation. In addition, the supramarginal gyrus (inferior pari-

etal cortex) showed activation during the maintenance of the sequence and temporal representation of the information while memorizing. In regard to the activation pattern presented by the supramarginal and superior temporal gyrus, these regions seem to functionally resemble the phonological buffer (phonological storage system), a component from the Baddeley's multicomponent model, that is, their function could be more specifically linked to language processing. The WM neural system involves other regions of non-specific fronto-parietal activation, such as the superior and inferior parietal cortex and the dorsolateral frontal cortex (middle and superior frontal gyrus). These areas interact with each other through frontal-parietal connections, providing attentional, sequential and variable cognitive load support in different WM tasks (Eriksson et al., 2015).

In children, studies assessing neural activation in WM are rare. Few meta analyses show only partial agreement with the neural network activated in WM in adults. For the N-back task in which the participants are asked to remember a past stimulus (in the previous position or in 2 positions back) and indicate whether the current stimulus is the same, children activated similar regions as adults in the posterior part, but not in the frontal portion of cortex. The posterior part of the brain, as discussed in the previous paragraph, included the superior and inferior parietal cortex, portions that connect with the frontal cortex. Since the posterior regions mature before the frontal portions, there is evidence that WM in children mainly in visuospatial tasks can operate at least partially with the same neural structures as in adults (Yaple & Arsalidou, 2018).

The neural maturation of the brain may also be evaluated by the thickness of the gray matter also called the cortex. With growth, the cortex tends to decrease in thickness, which reflects neural reorganization in favor of greater efficiency; a process that goes on until the late adolescence. In children aged 6 to 16 years, the reduction in cortical thickness of some regions was correlated with the performance in the central executive, such as the corpus callosum, bilateral posterior temporal cortex and left occipito-temporal cortex. Along with cortical thickness, changes were found in the brain white matter, which form bundles called fascicles, connecting important regions of the cortex. In children, neural connectivity indicates the use of general processing systems that, with increasing age, reorganize into specialized circuits found in adults. Younger children show a more distributed system of white matter bundles in both hemispheres, whereas in older children specific regions correlate more with performance in WM, for example, the left occipito-temporal cortex responsible for lexical word recognition and lately maturing the dorsolateral prefrontal cortex (Bathelt et al., 2018).

One of the reasons for having relatively few studies with fMRI in children is the technique's high cost and the prerequisite for acquiring quality data. The child must perform a task lying down inside the MRI machine and remain move less for about 10 to 20 minutes, which may be difficult even for many adult volunteers. In this sense, more ecological techniques have emerged that respect the nature of specific groups, such as children and can be applied in their natural environment, for example, at schools.

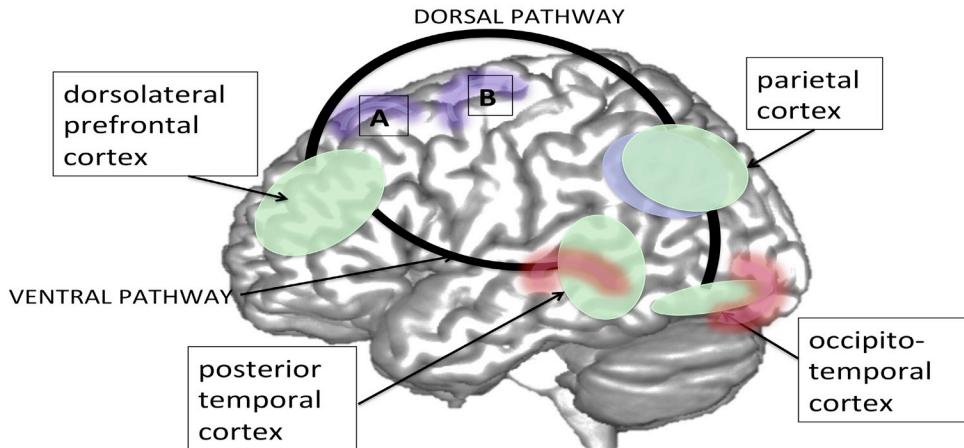


Figure 1. Scheme of neural areas (in fMRI studies) involved in WM tasks. Adults (green) activate regions of specific functioning such as posterior temporal cortex (upper, middle and lower temporal gyrus), occipito-temporal cortex and regions of non-specific activation such as parietal cortex (supramarginal gyrus) and dorsolateral frontal cortex (upper and medium). In children (purple), activation similar to that of adults occurs in the parietal cortex and in regions different from those of adults in the frontal cortex (superior frontal gyrus; B- precentral gyrus). In red: locations of lesser cortical thickness in children with better performance of the central executive. (Figure prepared with MRIcron based on the studies by Bathelt et al., 2018; Yaple & Arsallidou, 2018; Eriksson et al., 2015).

THE USE OF FNIRS TO ASSESS WM IN SCHOOLCHILDREN: AN EXPERIENCE REPORT

One of these techniques is fNIRS (functional near-infrared spectroscopy), which uses emission and capture of infrared light, able to penetrate cortical tissues and interact with hemoglobin in the blood. Hemoglobin absorbs part of the infrared light and disperses the rest; the

proportion of absorbed and scattered light changes, depending on the degree of hemoglobin binding to oxygen. Brain activity causes changes in the concentration of oxygen, and consequently in the concentration of oxygenated hemoglobin (oxy) and deoxygenated hemoglobin (deoxy). fNIRS will therefore measure, according to the difference between the amount of infrared light emitted and captured, changes in the concentration of oxy and deoxy hemoglobin, which will be correlated to brain activity (Pinti et al., 2018).



Figure 2. fNIRS equipment. The instrument consists of a cap with optodes (sources and detectors of infrared light) whose locations in the scalp are mapped according to the brain areas to be observed.

Functional near-infrared spectroscopy is non-invasive and does not require immobilization, which is advantageous for studies with children.

It is also robust against muscle movements, a significant utility for studies of language development that involve speech production. In addition, it does not produce loud noises like those generated by magnetic resonance, not interfering with tasks that require the presentation of auditory stimuli, and its portability allows data collection in naturalistic environments. Thus, the use of this technique has grown considerably, being evaluated as one of the most appropriate tools to investigate changes in brain activation in the field of educational neuroscience, and it can be used for cognitive studies on the development of reading, writing and math skills in schoolchildren (Pinti et al., 2018).

The role of WM in the literacy process is investigated through cognitive assessment and verification of neural correlates that point to changes in WM, in general by the activity of the left temporal and parietal cortex and the prefrontal cortex bilaterally. In our work, we focused on the prefrontal cortex to investigate changes in the executive component of WM as children acquired greater fluency in reading and writing. This region is considered part of a wider neural network, whose function is related to information update, attention modulation and focus maintenance during WM tasks (Moriguchi & Hiraki, 2013). Soltanlou, Sitnikova, Nuerk and Dresler (2018) specify that this network varies according to the complexity of the task, age and knowledge of the children.

In the project “Neural Correlates of the Development of Oral and Written Language Skills in Children in Typical Development”, developed at the Federal University of ABC (UFABC), the goal was to study the process of literacy and cognitive skills in children in typical cognitive devel-

opment through fNIRS. In particular, we sought to observe, at the neural level, the development of WM according to age progression.

For this, students from the 2nd to the 5th grades of a public school, in expected acquisition of literacy, were evaluated. The evaluations were carried out at the school: children were called individually and taken to a separate room within the institution. In the room, the children sat in front of a computer and the cap was placed on their scalp; the positioning regions of the optodes covered the frontal lobes.

The digit span task is a classic measure to assess WM capacity, constituting a consolidated research tool in cognitive psychology (Conway et al., 2005), and was the one we chose as an instrument for this study, being performed simultaneously with the acquisition of the neural signal by fNIRS. The stimuli were presented in a computerized way (through the computer screen and sound). Two tasks were proposed: one in which the digits should be repeated in direct order and another in which the repetition should be done in reverse order. Each task was performed for 5 minutes. On the direct order (forward digit span), the volunteer should listen (instruction represented by a red cross on the screen) a recorded number sequence and then repeat (instruction represented by a green cross) the same sequence, a task that is more related to the phonological loop component of WM (phonological storage and subvocal rehearsal). The second task followed the same procedure, but it was requested that the children repeated the sequence in reverse order, that is, starting from the last number of the original sequence and ending with the first (backwards digit span). This second task reflects the functioning of the

central executive component of WM, as the individual must store and manipulate verbal information, requiring, in addition to reverberation, a mental manipulation of the sequence. The size of the presented sequence was adjusted for each child according to their results in the cognitive assessment (span of digits in reverse order), that is, the children were evaluated with fNIRS to the greatest extent that they were able to successfully reproduce in the reverse order, and the same span was used for direct order. For example, if the volunteer obtained a 3-digit span in the reverse order during the cognitive assessment, he performed both the forward and backwards digits task in the 3-span during the fNIRS assessment. This means that the task in direct order was quite simple, and supposedly recruited the phonological loop more specifically.

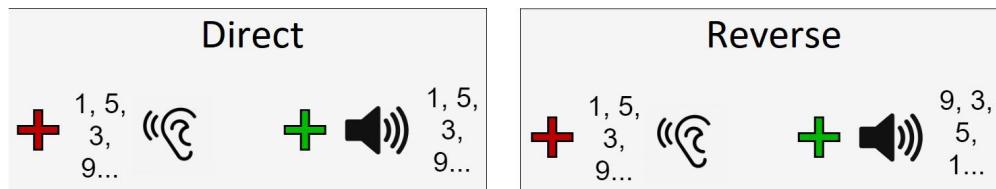


Figure 3. Diagram of the Digits task. When the screen showed a red cross, the participant should hear the sequence. When the cross turned green, he should repeat the sequence in direct or reverse order. A white cross indicated a moment of rest, between the sequences.

Below are examples of patterns detected in the study. Activation in the direct task was subtracted from activation in the reverse task (ie: Reverse Order - Direct Order) to verify the resulting activation, which would be related to the executive component of the WM:

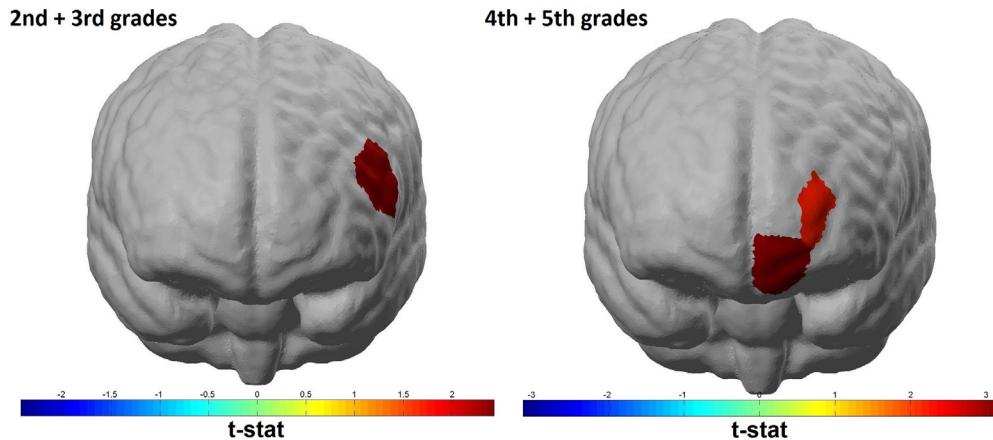


Figure 4. Thresholded activation (p -value <0.05) for the youngest children (2nd + 3rd grades) and for the oldest (4th + 5th grades).

The t-stat scale comprises the results of the statistics used to identify brain regions with significant activity; the values range from negative (blue) to positive (red). In the image, it is possible to observe significant positive activity in two regions: on the left (2nd and 3rd grade children), the dorsolateral prefrontal cortex and, on the right (4th and 5th grade children), the medial orbitofrontal cortex. These findings suggest that younger individuals are able to store / manipulate information (skills related to the dorsolateral prefrontal cortex), but do not efficiently use inhibitory control mechanisms (skills related to the medial orbitofrontal cortex), present in older individuals, who use both features.

These results may explain the increase in WM capacity with age: older children were able to perform the task with a longer digit sequence than younger children. It was also possible to observe, in general, a trend of evolution of reading and writing skills - measured through

cognitive assessments - with school progression, suggesting that there is a relationship between the growth of receptive and expressive vocabulary and the increase in the efficiency of WM, based on the refinement of neural activity.

FINAL CONSIDERATIONS

Our experience with fNIRS suggests that this tool has great potential to contribute to studies of language development, allowing for the monitoring of neural changes underlying the cognitive changes assessed at the clinic or school. The technique has simple set-up and allows for a quick assessment in schools, minimizing the disadvantages of a laboratory context for the acquisition of research data. The children had good acceptance and interest in participating in the experiment and looked calm and relatively comfortable during the performance of the proposed tasks. Their parents or caregivers were also able to get to know and monitor the procedures of the study, clarifying any doubts with the researchers. Finally, research at the school itself made it possible for the research team to connect with the entire school team with important exchanges of knowledge. This experience was then beneficial to everyone involved.

In relation to our findings, we observed changes in the capacity of the WM system and functional differences in the prefrontal cortex, during the performance of tasks involving this system. The different hemodynamic activity profiles in the prefrontal cortex may indicate the use of different strategies, which, in turn, may indicate that children are at different stages of cognitive development.

The results can be used as a basis for teaching interventions and for studying changes in language acquisition, since they characterize a typical development pattern useful for comparisons.

REFERENCES

- Baddeley A. (2015) Working memory. In Baddeley A, Eysenck MW., & Anderson C. Memory. Psychological Press. 2nd ed. 711 Third Avenue, New York, NY 10017.
- Baddeley, A. (2010). Working memory. *Current biology*, 20(4), R136-R140.
- Baddeley, A. D., & Hitch, G. (1974). Working memory. In G.H. Bower (Ed.), *The psychology of learning and motivation: Advances in research and theory* (Vol. 8, pp. 47–89). New York: Academic Press.
- Baddeley, A., Gathercole, S., & Papagno, C. (1998). The phonological loop as a language learning device. In: Baddeley, A. *Exploring Working Memory: selected works of Alan Baddeley*. (pp. 164 - 198). Routledge, 2 Park Square, Milton Park, Abingdon, Oxon, 2018.
- Bathelt, J., Gathercole, S. E., Johnson, A., & Astle, D. E. (2018). Differences in brain morphology and working memory capacity across childhood. *Developmental science*, 21(3), e12579.
- Cardoso, A. M. D. S., Silva, M. M. D., & Pereira, M. M. D. B. Consciência fonológica e a memória de trabalho de crianças com e sem dificuldades na alfabetização (Phonological awareness and working memory of children with and without literacy difficulties). CoDAS, [online]. 2013, vol. 25, n. 2.
- Conway, A. R., Kane, M. J., Bunting, M. F., Hambrick, D. Z., Wilhelm, O., & Engle, R. W. (2005). Working memory span tasks: A methodological review and user's guide. *Psychonomic bulletin & review*, 12(5), 769-786.
- Cowan, N., Li, Y., Glass, B. A., & Scott Saults, J. (2017). Development of the ability to combine visual and acoustic information in working memory. *Developmental science*, 21(5), e12635.
- Demoulin, C., & Kolinsky, R. (2016). Does learning to read shape verbal working memory?. *Psychonomic bulletin & review*, 23(3), 703-722.

- Ehri, L. (1997). Learning to read and learning to spell are one and the same, almost. In C. A. Perfetti, L. Reiben, & M. Fayol (Eds.), *Learning to spell: Research, theory, and practice across languages* (pp. 237–269). Mahwah, NJ: Erlbaum.
- Ehri, L. (2005). Learning to read words: Theory, findings and issues. *Scientific Studies of Reading*, 9, 167–188.
- Eriksson, J., Vogel, E. K., Lansner, A., Bergström, F., Nyberg, L. (2015). Neurocognitive architecture of working memory. *Neuron* 88; 33 – 46.
- Eysenck, M. W., & Keane, M. T. (2010). *Cognitive psychology: A student's handbook*. Psychology press.
- Gathercole, S. E. (1999). Cognitive approaches to the development of short-term memory. *Trends in cognitive sciences*, 3(11), 410-419.
- Grivol, M. A., & Hage, S. R. D. V. (2011). Memória de trabalho fonológica: estudo comparativo entre diferentes faixas etárias (Phonological working memory: comparative study between different age groups). *Jornal da Sociedade Brasileira de Fonoaudiologia*, 23(3), 245-251.
- Lobo, F. S., Acrani, I. O., & Ávila, C. R. B. D. (2008). Tipo de estímulo e memória de trabalho fonológica (Type of stimulus and phonological working memory). *Revista CEFAC*, 10(4), 461-470.
- Miyake, A., & Shah, P. (Eds.). (1999). *Models of working memory: Mechanisms of active maintenance and executive control*. Cambridge University Press.
- Mommers, M. J. C. (1987). An investigation into the relation between word recognition skills, reading comprehension and spelling skills in the first two years of primary school. *Journal of Research in Reading*, 10, 122–143.
- Moriguchi, Y., & Hiraki, K. (2013). Prefrontal cortex and executive function in young children: a review of NIRS studies. *Frontiers in human neuroscience*, 7, 867.
- Park, D. C., Lautenschlager, G., Hedden, T., Davidson, N. S., Smith, A. D., & Smith, P. K. (2002). Models of visuospatial and verbal memory across the adult life span. *Psychology and aging*, 17(2), 299.
- Pinti, P., Tachtsidis, I., Hamilton, A., Hirsch, J., Aichelburg, C., Gilbert, S., & Burgess, P. W. (2018). The present and future use of functional near-infrared spectroscopy (fNIRS) for cognitive neuroscience. *Annals of the New York Academy of Sciences*.

- Pollatsek, A., Treiman, R. (2015). *The Oxford handbook of reading*. Oxford University Press.
- Seymour, P., Aro, M., & Erskine, J. (2003). Foundation literacy acquisition in European orthographies. *British Journal of Psychology*, 94, 143–174.
- Soltanlou, M., Sitnikova, M. A., Nuerk, H. C., & Dresler, T. (2018). Applications of functional near-infrared spectroscopy (fNIRS) in studying cognitive development: the case of mathematics and language. *Frontiers in psychology*, 9, 277.
- Yaple, Z., & Arsalidou, M. (2018). N-back working memory task: Meta-analysis of normative fMRI studies with children. *Child development*, 89(6), 2010-2022.

CHAPTER 7

A model for evaluation of students' neurobehavioral complaints in school context

Alessandra Gotuzzo Seabra

Decio Brunoni

Luiz Renato Rodrigues Carreiro

Tally Lichtensztein Tafla

Maria Cristina Triguero Veloz Teixeira

Neurodevelopmental disorders, according to the Diagnostic and Statistical Manual of Mental Disorders, fifth edition - DSM-5 (American Psychiatric Association [APA], 2014), make up a group of conditions that manifest early during the development period and can include various impairments, from specific limitations of learning and executive control to global impairments of intelligence and social skills. They often appear before the child's period of school entry and are characterized by diverse losses that reach the occupational, personal, academic and social spheres (APA, 2014).

Brazilian public policies, aligned with what is advocated in several other countries, reiterate the importance of early diagnosis of these disorders (Brasil, 2016). Such a recommendation is feasible because the main clinical characteristics of neurodevelopmental disorders are man-

ifested since the first years of life. Early identification and evaluation allow the establishment of a differential diagnosis, when necessary, and effective monitoring and intervention (Mansour et al., 2017).

However, in Brazil, as well as in other developing countries (Olashore et al., 2017), public policies that establish mandatory population screening in the detection of indicators of neurodevelopmental changes in the children are still scarce, either because of the lack of mental health tools or public educational networks (Bordini et al., 2015; Couto & Delgado, 2015; Paula et al., 2016; Bosa & Teixeira, 2017; Paula et al., 2018; Teixeira et al., 2017; Faria et al., 2018).

Among the most studied disorders, due to the impact they cause in school performance, are Intellectual Disability (ID) or Intellectual Development Disorder, Autistic Spectrum Disorder (ASD), Attention Deficit / Hyperactivity Disorder (ADHD) and Specific Learning Disabilities (SLD) (APA, 2014).

Impairments in intellectual skills and social and adaptive functioning, for example, deficits in intellectual functions such as reasoning, problem-solving, planning, abstract thinking, judgment, academic learning and deficit in adaptive functioning, characterize ID. It has a general prevalence in the population of approximately 1%, with variations due to age. Severe ID has a prevalence of about 6: 1,000 (APA, 2014). ASD is a disorder characterized by signs and symptoms related to persistent deficits in interaction and social communication and the presence of restricted and repetitive patterns of behaviors, interests or activities with impairments in adaptive functioning, whose prevalence has been estimated at around 1% (APA, 2014). Attention Deficit / Hyperactivity

Disorder is characterized by a persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with social, family and school functioning. It has an estimated prevalence in the child population of about 5% (APA, 2014). Specific Learning Disabilities are characterized by the presence of specific deficits in the individual's ability to perceive or process information efficiently, and its main identifiers are persistent difficulties in basic academic reading, writing and/or mathematical skills. The prevalence of this disability in the academic domains of reading, writing and mathematics is 5 to 15% among school children in different languages and cultures (APA, 2014).

There are differences among the disorders previously presented and the variations in development that are expected. For example, according to Paiva and Azevedo (2009), learning difficulties constitute a heterogeneous set of disorders, which can result from problems in hearing, speech, reasoning or other aspects, including ineffective teaching methodologies. That is, such difficulties should not be attributed exclusively to a disorder immanent from the child. This concern must be taken in all Neurodevelopmental Disorders.

Given the need for early identification of such disorders, in order to make the intervention feasible, professionals who work with children must be trained to identify possible signs of these conditions. This training is needed so we have appropriate referrals as well as they have tools to assist professionals in such identification and, whenever possible, they have knowledge on how to deal with children with different pictures in the classroom.

In fact, in school contexts in Brazil, teachers who work in the classroom are the main agents for identifying students with some type of school, emotional or developmental difficulties that affect academic performance and adaptive functioning. The formal academic learning process requires the student to develop several socio-behavioral repertoires and cognitive skills compatible with the requirements of the school and educational activities in the school context, namely: reading, writing, calculating skills, repertoires of social skills in relationship with pairs; assertive social skills of relationship with colleagues, carrying out academic group activities, solving interpersonal problems, among others (Ansary et al., 2017; Dias & Seabra, 2017; Guzmán et al., 2015; Del Prette, & Del Prette, 2008).

Children with neurotypical development may present variations in school performance and adaptive functioning in the different repertoires of skills mentioned in the previous paragraph, depending on gender, age, transient health problems, absenteeism from school and environmental factors related to social, educational and pedagogical stimulation, among others. (Silva & Cavalcante, 2015; Flatters et al., 2014; Osborn & Pereira, 2012). However, when a child has some type of complaint whose signs indicate gaps in development, it is recommended an evaluation as early as possible to check for the presence of a neurodevelopmental disorder or if it is some kind of intrinsic transient difficulty to the school adaptation process. For example, related to the learning style, socio-economic development, the student's ability to respond to the school environment, factors related to the family environment and/or temporary nature environment.

In the presence of indicative signs of neurodevelopmental disorders, the teacher must have skills, competences and, also, have adequate tools and/or instruments that allow him to identify and make an initial evaluation of the student so that, later, the student can receive, if necessary, other specialized evaluations and assistance that correspond to his needs (Li-Grining et al., 2010).

To assist such a process, in several countries, as in the United States, the use of evaluation technologies is already contemplated in government policies, helping preventive intervention actions in children with signs of neurodevelopmental disorders (Rotholz et al., 2013). In contrast, public policies that advocate the use of scientifically validated evaluation technologies remain scarce in developing countries like Brazil. Tracking indicators of learning difficulties and neurodevelopmental disorders in the first years of formal schooling is a demand that requires the use of standardized instruments, which can be optimized by technologies.

Currently, instrumentalization of these professionals in the use of evaluation tools have significantly benefited them from computer systems for data collection and analysis with applications in sectors such as economics, education and health (Turban et al., 2010; Silberschatz et al., 2006). Basic education is one of the appropriate contexts for the implementation of this type of technology, as these can assist in the collection, storage, monitoring and analysis of data from students enrolled in public education schools. In these computer systems, one of the devices with significant evolution has been the Database Management Systems, both in the aspect of storage and data mining (Silva et al., 2017). These

systems act as a resource for the creation of fact or transaction repositories and, consequently, can be data analysis sources with a focus on the generation of management reports for follow-up or monitoring tasks and actions in the most diverse areas of human knowledge.

In order to instrumentalize the teacher in the identification of signs that may indicate neurodevelopmental disorders, as well as to train him or her on how to work in the classroom, especially with children with ADHD and SLD, a research project has been conducted with the municipality of Embu das Artes. The main objectives of this project are: a) To instruct teachers and educational managers in the use of standardized evaluation procedures and instruments for screening students with suspected of ID, ASD, SLD and ADHD; b) To develop and implement a computer system in basic education with four models that assist in decision-making to attribute to a student of basic education the suspicion of neurodevelopmental disorder compatible with ID, TEA, ADHD or SLD; c) To instruct teachers and educational managers in the use of standardized evaluation procedures in a computational environment for screening students with these suspicions; d) To instruct teachers in the use of interventional measures for students at risk for ADHD and SLD and to evaluate the effects of these interventions; e) To verify sensitivity indicators of standardized screening and cognitive and behavioral evaluation procedures based on the number of false positive and false negative cases; f) To verify that the Big Data environment, for data storage and analysis, contributes to the reduction of impoundments of students who need definitions as to the type of school and/or cognitive and/or behav-

ioral complaints; g) To check the participants' satisfaction indicators in the use of the Computational System, specially the potential using in the basic education context.

Data collection have already been conducted throughout 2019, and the results have been analyzed so far. In 2020, an article was published describing the initial steps referring to two disorders, ASD and ID (Teixeira et al., 2020). According to the article, the study related to these two disorders was carried out in two stages. In the first stage, two checklists were developed, directed to teachers, with descriptions of the characteristics of the disorders, based on the DSM-5 (APA, 2014). Subsequently, the instrument's construct validity was verified, based on the analysis of judges, with the criteria analysis of clarity, precision and objectivity. A final version of the checklists for ASD and DI was then made.

Then, in the second stage, flowcharts were developed, one for each disorder, consisting of a set of sequential activities, organized logically, which illustrated the process to be followed by the different actors. Thus, the tasks of the teacher, the specialized educational service team and the educational network managers were defined. Such flowcharts, therefore, help in the organization of actions that can be developed within the very educational networks, until reaching a possible referral to the health system, when necessary. The procedure for developing the flowcharts was based on the Business Process Model and Notation (BPMN) and used the Business Process Management System (BPMS) platform open code. At the end of the evaluation process, before possible referral (or not) to the health system, a final report of each student is produced,

which contains the evaluation results, such as checklist indicators, neuropsychological emotional and behavioral evaluations (Teixeira et al., 2020).

As previously stated, mental health professionals must perform the last activity drawn in the flowcharts in order to proceed to the evaluation to confirm or not the diagnosis. It is emphasized that for the proper implementation of this procedure, teachers, professionals of the specialized educational assistance team and managers must receive specific training on expected milestones of child development in the specific cognitive, behavioral and functional aspects of each neurodevelopmental disorder involved in the project. They must also receive training on the entire procedure to be used.

As already published for ASD and ID, data regarding the procedures used with ADHD and SLD are being analyzed and organized. It is noteworthy that, for these last two disorders, the procedure includes an intervention made by the teachers themselves in the classroom since, according to the DSM-5 (APA, 2014), the students' response to scientifically based interventions, conducted in context education, is also necessary for diagnosis and possible referral to the health system.

The diagnosis of SLD itself, according to the DSM-5 (APA, 2014), includes the concept of persistence of difficulties to make the diagnosis possible, defined as limited progress in learning to read, write and/or math, despite adequate instructions offered to the child at school or home. Therefore, it is essential to verify whether the child with suspected SLD has a response that is less than expected (for age and grade)

when receiving the appropriate intervention (Miranda et al., 2017). According to DSM-5, this can be observed, for example, when a child has difficulties in learning to read isolated words that “do not solve completely or quickly with the provision of instructions on phonological skills or strategies for identifying words” (APA, 2014, p. 68). For this reason, in the model reported in this chapter, there is a moment of intervention, made by the teachers themselves, in the classroom, aimed at students with suspected of ADHD and SLD, so that the students’ responses to the intervention and the persistence of difficulties are analyzed to continue the evaluation process and possible diagnosis.

The DSM-5 guidelines for the diagnosis of SLD, in which intervention with a revaluation of the child is recommended, then, in case the difficulties persist, the diagnostic evaluation process starts (APA, 2014). This is our recommendation for ADHD cases. Considering that the signs of ADHD may be symptomatologically mixed with other conditions or with deficits in behavioral repertoires for socialization, or behavioral repertoires for studying (Daley et al., 2018; Barlow et al., 2016), it is recommended that children who show ADHD signs undergo behavioral interventions based on scientific evidence. After these interventions, children should be reevaluated. In addition, if the signs of inattention and hyperactivity persist compared to the expected milestones of child development, the diagnostic evaluation should be conducted.

Identifying neurodevelopmental disorders in school networks presupposes a good integration with the health system of the municipality and/or region in which the school is located; however, this synchroniza-

tion between health and education actions has not always been possible in the Brazilian context (Teixeira et al., 2017). For example, data from a school network in a municipality in the state of São Paulo showed that about 30% of ASD diagnoses, in which students are registered, did not support the students' needs after an intense investigation by an interdisciplinary team (Garcia et al., 2016).

This fact is certainly repeated in Brazilian municipalities due to the lack of dialogue between the Health System and the Education System. In fact, the literature reflects what probably happens in reality: lack of structured protocols for mental health professionals to investigate cognitive-behavioral aspects of children in Specialized Educational Care, and teachers highlighting the difficulty of communicating with health. This panorama is very well demonstrated by Mendes, Cia and Valadão (2015) in volume 4 of the National Observatory of Special Education Series (known in Brazil as Série Observatório Nacional de Educação Especial). The book shows the experience of the operation of the Multifunctional Resource Rooms in 37 municipalities in five Brazilian regions, and the lack of integration between education and health is repeatedly highlighted. Silva et al. (2016) also point out this fact. The authors investigated the teachers' perception of the functioning of this interface, in the city of Santos, SP. The article concludes by showing deficient cooperation between the two areas.

In the Brazilian public system, it is expected that evaluations in the mental health area will be carried out by the Psychosocial Care Center (known in Brazil as Centro de Atenção Psicossocial – CAPS). In the case

of the disabilities, considered here, the children's modality of these Centers, the CAPSi (known in Brazil as Centro de Atenção Psicossocial Infantil), is responsible. In the operating structure of these bodies, matrix support is provided, which includes involvement with the schools in which assisted children are enrolled. The case of ASD, in which there is more abundant information, illustrates what should occur with other disorders.

The National Policy for the Protection of the Rights of People with Autism Spectrum Disorder, Law 12.764 / 2012 (Brazil, 2012) provides in Article 2 for "comprehensive attention to the health needs of people with ASD, aiming at early diagnosis, multidisciplinary care and access to medicines and nutrients." Such assistance can occur in the Unified Health System (Known in Brazil as Sistema Único de Saúde – SUS). It is organized regionally through a decentralized but connected network of health services and related activities, made up of a complex number of facilities, both public and private, to provide care. As part of SUS, the Psychosocial Care Network (Known in Brazil as Rede de Atenção Psicossocial – RAP) works along with other health networks and programs, such as the Family Health Program (Known in Brazil as Programa de Saúde da Família - PSF) and the Care Network for People with Disabilities (Known in Brazil as Rede de Cuidados da Pessoa com Deficiência - RCPD). Besides, there is a connection between educational and social systems. The CAPSis are part of RAP, which are places directly involved with diagnostic evaluation and intervention.

Designed in this way, the system should function properly to correspond with the guidelines recommended in the law mentioned above

(Brasil, 2012). However, in practice, the situation is different, even including in the Guidelines produced by the Ministry of Health (MH). In fact, both professionals linked to RAP and those linked to RCPD have produced guidelines for the care of individuals with ASD in the SUS network. Such documents, are called “Guidelines for Attention to Rehabilitation of People with Autism Spectrum Disorders (ASD) (available at http://bvsms.saude.gov.br/bvs/publicacoes/diretrizes_atencao_reabilitacao_pessoa_autismo.pdf). The Health General Coordination for People with Disabilities led this document. The group linked to the “National Coordination of Mental Health, Alcohol and Other Drugs” produced the document called “Care Line for the Attention of People with ASD and their Families in the Psychosocial Care Network of the Unified Health System (available at http://bvsms.saude.gov.br/bvs/publicacoes/linha_cuidado_atencao_pessoas_transtorno.pdf). The excellent article by Rios and Andrade (2015) indicates the philosophical conception of the two groups in the understanding of the individual with autism. Different positions concerning diagnosis and intervention result from it.

With such a situation, the need to produce research in this area is evident, in both university and public services, so that it is possible to understand exactly how people with autism and their families are being welcomed, evaluated and assisted in these places. From this point of view, Brazilian production is restricted. The studies point out the need to promote clinical training, including training in diagnostic instruments and early diagnosis. From the point of view of existing services, the need to expand knowledge of best practices in this area, increase the capacity

of these services and establish training programs for pediatricians and family doctors (Teixeira et al., 2010; Paula et al., 2011; Ribeiro et al., 2017). From CAPSis, the work of Ceballos et al. (2019), profiles them from 2008 to 2012 in 837,068 records, in all Brazilian regions. It finds out that ASD represents the second frequency diagnosis in the system (12.4%).

CONCLUSION

This chapter summarizes a process model for teachers and educational administrators, which uses a computerized system to assist them in collecting and analyzing data, as well as making a decision in real-time to identify students with suspected neurodevelopmental disorders.

The hope is that the chapter will help teachers and educational managers with models for evaluating students' neurobehavioral complaints, in order to identify suspected neurodevelopmental disorders compatible with DI, ASD, ADHD or SLD. In addition, educators can include in these models the evaluations of signs of these disorders in real-time, prioritizing the verification of impacts on school performance and behavioral patterns of functioning. On the other hand, the chapter can assist them in making joint decisions along with the students' families to carry out school and behavioral interventions with the children in the classroom and later verification of the persistence of these signs. With these contributions, teachers and managers will be able to implement actions of the intersectionality guidelines between education and health. In this sense, teachers, through parents and caregivers, will be able to recom-

mend the student's referral to health services when persistent neurobehavioral complaints need diagnostic evaluations. Models such as the one described here can minimize the long delays of students waiting for an evaluation and, at the same time, optimize the use of specialized services from the SUS or specialized services in the educational network.

REFERENCES

- Al-Yagon, M. (2011). Fathers' coping resources and children's socioemotional adjustment among children with learning disabilities. *Journal of Learning Disabilities*, 44(6), 491-507. doi: 10.1177/1087054710378582.
- American Psychiatric Association. (2014). *DSM-5: Manual diagnóstico e estatístico de transtornos mentais*. Artmed Editora.
- Ansary, N. S., McMahon, T. J., & Luthar, S. S. (2017). Trajectories of emotional-behavioral difficulty and academic competence: A 6-year, person-centered, prospective study of affluent suburban adolescents. *Development and Psychopathology*, 29(1), 215-234. doi: 10.1017/S0954579416000110.
- Barlow, J., Smailagic, N., Ferriter, M., Bennett, C., & Jones, H. (2010). Group-based parent-training programmes for improving emotional and behavioural adjustment in children from birth to three years old. *Cochrane Database of Systematic Reviews*, (3). doi: 10.1002/14651858.CD003680.pub2.
- Barnes, M. A., Raghubar, K. P., English, L., Williams, J. M., Taylor, H., & Landry, S. (2014). Longitudinal mediators of achievement in mathematics and reading in typical and atypical development. *Journal of Experimental Child Psychology*, 119, 1-16. doi: 10.1016/j.jecp.2013.09.006.
- Bordini, D., Lowenthal, R., Gadelha, A., Araujo Filho, G. M. D., Mari, J. D. J., & Paula, C. S. (2015). Impact of training in autism for primary care providers: a pilot study. *Brazilian Journal of Psychiatry*, 37(1), 63-66. doi: 10.1590/1516-4446-2014-1367.
- Bosa, C. A., & Teixeira, M. C. T. V. (2017). *Autismo: avaliação psicológica e neuropsicológica* (Autism: psychological and neuropsychological assessment). Hogrefe-Cetepp.

BRASIL. Lei Nº 12.764, DE 27 DE DEZEMBRO DE 2012. Institui a Política Nacional de Proteção dos Direitos da Pessoa com Transtorno do Espectro Autista; e altera o § 3º do art. 98 da Lei nº 8.112, de 11 de dezembro de 1990.

BRASIL. Ministério da Saúde. Cartilha para apresentação de propostas ao Ministério da Saúde (Primer for submitting proposals to the Ministry of Health). Brasília, 2016.

Ceballos, G. Y., Paula, C. S., Ribeiro, E. L., & Santos, D. N. (2019). Child and Adolescent Psychosocial Care Center service use profile in Brazil: 2008 to 2012. *Brazilian Journal of Psychiatry*, 41(2), 138-147. doi: 10.1590/1516-4446-2018-0011.

Couto, M. C. V., & Delgado, P. G. G. (2015). Crianças e adolescentes na agenda política da saúde mental brasileira: inclusão tardia, desafios atuais (Children and adolescents on the Brazilian mental health policy agenda: late inclusion, current challenges). *Psicologia Clínica*, 27(1), 17-40. doi: 10.1590/0103-56652015000100002.

Daley, D., Van Der Oord, S., Ferrin, M., Cortese, S., Danckaerts, M., Doepfner, M. & Banaschewski, T. (2018). Practitioner review: current best practice in the use of parent training and other behavioural interventions in the treatment of children and adolescents with attention deficit hyperactivity disorder. *Journal of Child Psychology and Psychiatry*, 59(9), 932-947. doi: 10.1111/jcpp.12825.

Del Prette, Z. A. P., & Del Prette, A. (2008). Um sistema de categorias de habilidades sociais educativas (A system of educational social skills categories). *Paidéia (Ribeirão Preto)*, 18(41), 517-530. doi: 10.1590/S0103-863X2008000300008.

Dias, N. M., & Seabra, A. G. (2017). School performance at the end of elementary school: Contributions of intelligence, language, and executive functions. *Estudos de Psicologia (Campinas)*, 34(2), 315-326. doi: 10.1590/1982-02752017000200012.

Faria, K. T., Teixeira, M. C. T. V., Carreiro, L. R. R., Amoroso, V., & de Paula, C. S. (2018). Atitudes e práticas pedagógicas de inclusão para o aluno com autismo (Inclusive pedagogical attitudes and practices for students with autism). *Revista Educação Especial*, 31(61), 353-370. doi: 10.5902/1984686X28701.

Flatters, I., Hill, L. J., Williams, J. H., Barber, S. E., & Mon-Williams, M. (2014). Manual control age and sex differences in 4 to 11-year-old children. *PLoS one*, 9(2). doi: 10.1371/journal.pone.0088692.

- Garcia, A. H. C., Viveiros, M. M., Schwartzman, J. S., & Brunoni, D. (2016). Transtornos do espectro do autismo: avaliação e comorbidades em alunos de Barueri, São Paulo (Autism spectrum disorders: evaluation and comorbidities in students from Barueri, São Paulo). *Psicologia: teoria e prática*, 18(1), 166-177. doi: 10.15348/1980-6906/psicologia.v18n1p166-177.
- Guzmán, J., Kessler, R. C., Squicciarini, A. M., George, M., Baer, L., Canenguez, K. M.,... & Murphy, J. M. (2015). Evidence for the effectiveness of a national school-based mental health program in Chile. *Journal of the American Academy of Child & Adolescent Psychiatry*, 54(10), 799-807. doi: 10.1016/j.jaac.2015.07.005.
- Li-Grining, C. P., Votruba-Drzal, E., Maldonado-Carreño, C., & Haas, K. (2010). Children's early approaches to learning and academic trajectories through fifth grade. *Developmental Psychology*, 46(5), 1062. doi: 10.1037/a0020066.
- Mansour, R., Dovi, A. T., Lane, D. M., Loveland, K. A., & Pearson, D. A. (2017). ADHD severity as it relates to comorbid psychiatric symptomatology in children with Autism Spectrum Disorders (ASD). *Research in developmental disabilities*, 60, 52-64. doi: 10.1016/j.ridd.2016.11.009.
- Mendes, E. G., Cia, F., & Tannús-Valadão, G. (2015). Inclusão escolar em foco: organização e funcionamento do atendimento educacional especializado (School inclusion in focus: organization and functioning of specialized educational assistance). *São Carlos*.
- Miranda, M. C., Capellini, S. A., & Seabra, A. G. (2017). Rti como abordagem da identificação da dislexia do desenvolvimento (Rti as an approach to the identification of developmental dyslexia). In: Salles, J. F.; Navas, A. L. (Org.). *Dislexias do Desenvolvimento e Adquiridas*. (1 ed.; p 51-63) São Paulo: Editora Pearson Clinical Brasil, 2017.
- Olashore, A. A., Frank-Hatitchki, B., & Ogunwobi, O. (2017). Diagnostic profiles and predictors of treatment outcome among children and adolescents attending a national psychiatric hospital in Botswana. *Child and adolescent psychiatry and mental health*, 11(1), 8. doi: 10.1186/s13034-017-0144-9.
- Osborn, E., & Pereira, L. D. (2012). Neuropsychological aspects of 10-year-old children. *Einstein (São Paulo)*, 10(4), 433-438. doi: 10.1590/S1679-45082012000400007.
- Paiva, M.G.V.; Azevedo, P.G. Dificuldades de aprendizagem: enfoque psicopedagógico (Learning difficulties: psychopedagogical approach). In: Montiel, J. M.; Capovilla,

F. C. (Orgs.). *Atualização em Transtorno de Aprendizagem*. São Paulo: Artes Médicas, 2009.

Paula, C. S., Fombonne, E., Gadia, C., Tuchman, R., & Rosanoff, M. (2011). Autism in Brazil: perspectives from science and society. *Revista da Associação Médica Brasileira*, 57(1), 2-5. doi: 10.1590/S0104-42302011000100002.

Paula, C. S., Mari, J. J., Bordin, I. A. S., Miguel, E. C., Fortes, I., Barroso, N.,... & Coutinho, E. S. F. (2018). Early vulnerabilities for psychiatric disorders in elementary schoolchildren from four Brazilian regions. *Social psychiatry and psychiatric epidemiology*, 53(5), 477-486. doi: 10.1007/s00127-018-1503-4.

Paula, C. S., Belisário Filho, J. F., & Teixeira, M. C. T. V. (2016). Estudantes de psicologia concluem a graduação com uma boa formação em autismo? (Do psychology students complete their degree with a good background in autism?). *Revista Psicologia-Teoria e Prática*, 18(1). doi: 10.15348/1980-6906/psicologia. v18n1p206-221.

Ribeiro, S. H., Paula, C. S. D., Bordini, D., Mari, J. J., & Caetano, S. C. (2017). Barriers to early identification of autism in Brazil. *Brazilian Journal of Psychiatry*, 39(4), 352-354. doi: 10.1590/1516-4446-2016-2141.

Rios, C., & Andrade, B. C. (2015). The changing face of autism in Brazil. *Culture, Medicine, and Psychiatry*, 39(2), 213-234. doi: 10.1007/s11013-015-9448-5.

Rothholz, D. A., Moseley, C. R., & Carlson, K. B. (2013). State policies and practices in behavior supports for persons with intellectual and developmental disabilities in the United States: A national survey. *Mental Retardation*, 51(6), 433-445. doi: 10.1352/1934-9556-51.6.433.

Silberschatz, A., Korth, H. F., Sudarshan, S., & Pérez, F. S. (2007). *Fundamentos de diseño de bases de datos* (Database Design Fundamentals). McGraw-Hill.

Silva, C. C. B. D., Molero, E. S. D. S., & Roman, M. D. (2016). A interface entre saúde e educação: percepções de educadores sobre educação inclusiva (The interface between health and education: educators' perceptions of inclusive education). *Psicología Escolar e Educacional*, 20(1), 109-115. doi: 10.1590/2175-353920150201934.

Silva, L. A., Peres, S. M., & Boscarioli, C. (2017). *Introdução à mineração de dados: com aplicações em R* (Introduction to data mining: with applications in R). Elsevier Brasil.

Silva, T. A. D., & Cavalcante, L. I. C. (2015). Habilidades sociais e características pessoais em escolares de Belém (Social skills and personal characteristics in schoolchildren from Belém). *Psicologia: Reflexão e Crítica*, 28(4), 850-858. doi: 10.1590/1678-7153.201528424.

Teixeira, M. C. T. V., Brunoni, D., Carreiro, L. R. R., Braga, A. C., Silva, N. A. D., & Paula, C. S. (2017). Mismatch between diagnostic reports and special educational needs classification in a public educational system. *Arquivos de neuro-psiquiatria*, 75(4), 244-247. doi: 10.1590/0004-282x20170025.

Teixeira, M. C. T. V., Carreiro, L. R. R., Seabra, A. G., da Silva, L. A., Rossi, A. C., Tafla, T. L.,..., & Brunoni, D. (2020). Modelo de tomada de decisão para uso de professores do ensino fundamental na identificação de Autismo e Deficiência Intelectual (Decision making model for the use of elementary school teachers in the identification of Autism and Intellectual Disability). *ETD-Educação Temática Digital*, 22(1), 106-126. doi: 10.20396/etd.v22i1.8655539.

Teixeira, M. C. T. V., Mecca, T. P., Velloso, R. D. L., Bravo, R. B., Ribeiro, S. H. B., Mercadante, M. T., & Paula, C. S. D. (2010). Literatura científica brasileira sobre transtornos do espectro autista (Brazilian scientific literature on autism spectrum disorders). *Revista da Associação Médica Brasileira*, 56(5), 607-614. doi: 10.1590/S0104-42302010000500026.

Turban, E., Leidner, D., Mclean, E., & Wetherbe, J. (2010). *Tecnologia da Informação para Gestão: Transformando os Negócios na Economia Digital* (Information Technology for Management: Transforming Business in the Digital Economy). Bookman.

CHAPTER 8

Contributions of science to the study of language and reading development

Patrícia Botelho da Silva

Amanda Douat Cardoso

Tais Morosi Lara Campos

Elizeu Coutinho de Macedo

Reading can be considered the most important form of access to academic information. However, learning to read is a complex process and requires different skills. This learning process involves the explicit presentation of the alphabetical principle. However, some skills can be assessed even before the literacy process begins and they have been shown to be predictors of learning. Among the predictive skills, rapid automatized naming (RAN) and phonological awareness (PA) stand out (Handler & Fierson, 2011).

RAN is the ability to name a series of symbols (e.g., letters, numbers, colors or object) as quickly as possible. Thus, it is possible to analyze individuals' ability to perceive and quickly and accurately access the names of different types of symbols. This ability is related to the time when information is processed as it integrates the recognition of visual stimuli with the expressive aspects of language. Such a skill demands the inte-

gration of different cognitive functions such as perception, motor skills, attention, language, and executive functions (Wolf & Denckla, 2005).

PA is another skill described in literature as being of great importance for the development of reading. This ability is related to phonological decoding, helping to convert visual symbols into their sounds. Therefore, PA is a measure that correlates with the subsequent ability of reading accuracy (Cardoso-Martins & Pennington, 2001). In fact, numerous studies (e.g., Pazeto, León, & Seabra, 2017) demonstrated an increase in PA with school progression, reinforcing the importance of teaching this skill in literacy classes, which is widely shown to be related to reading and writing performance.

The present chapter intends to emphasize and expand the discourse on RAN ability, emphasizing its relationship with PA ability and acknowledging that reading is a complex process that develops with the automation and development of cognitive processes such as word recognition, comprehension, and fluency.

READING DEVELOPMENT

The main purpose of reading development is to comprehend the material read. According to the simple view of reading theory, reading and comprehending are the product of the development of two basic skills: decoding and oral comprehension. This model is represented by the equation $R = D \times L$, where R stands for reading, D for decoding capacity; and L for comprehending oral language. Therefore, according to the equation, if there is damage or difficulty in one of the two skills (D or

L), reading will be deficient (Gough & Tunmer, 1986; Protopapas, Simos, Sideridis, & Mouzaki, 2012).

Decoding is the ability to read isolated words quickly and accurately. Thus, decoding makes use of letter–sound correspondence rules, which are important for the recognition of words (Protopapas et al., 2012). Based on that, another model, proposed by Aaron, Joshi, Gooden, and Bentum (2008), recommends changing the use of terms in relation to decoding and proposes the use of the term word recognition, since word recognition involves both decoding and visual reading skills.

Theoretically, word recognition consists of components dependent on written material (decoding and word reading) and independent components of written material (verbal and oral skills and metalinguistic skills that are not related to written material). Within the first component, relevant measures include knowledge of the letter–sound conversion, fluency, and speed, with the ability for RAN relevant to the good development of these skills and, therefore, to the understanding of reading. Within the second component, the relevant measures are auditory comprehension and vocabulary (Protopapas, Mouzaki, Sideridis, Kotsolakou, & Simos, 2013; Protopapas et al., 2012). From this explanatory model, adaptations and new proposals emerged to explain how reading skills develop.

According to one model (Seabra, 2011), reading development depends on three specific domains, each containing specific and essential skills. The first domain is cognitive; it includes skills such as word recognition, comprehension, and fluency. The second domain, “additional

psychological,” is related to motivation, gender, and other psychological factors that do not involve cognitive skills. The last component involves environmental aspects that influence the development of learning how to read and includes aspects such as teacher expectations, family/cultural and school environment, peer influence and language (Seabra, 2011). In the next section, we discuss cognitive skills: word recognition, comprehension, and fluency.

WORD RECOGNITION

Several cognitive models have been proposed to explain information processing during word recognition. These models were developed to explain what steps are involved in word processing, and how. One of the first such models is the dual-route cascaded model (Taylor, Rastle, & Davis, 2013), which suggests that word recognition consists of the phonological and lexical route. The phonological route is related to the process of grapheme–phoneme conversion whereas in the lexical route, morphological units are analyzed without the need for phonological decoding; thus, analysis of the word as a whole occurs (Ellis, Young, & Anderson, 1988). Reading through the lexical route is consolidated based on the “frequency effect,” in which repeated exposure to the same word enables lowering the threshold of information necessary to activate the direct visual analysis system, making reading more fluid.

A new model, the connectionist dual-process model (Taylor et al., 2013), also suggests that word recognition is formed by two routes: lexical and sublexical. The lexical route is identical to that of the dual-route

model. The sublexical network, on the other hand, is not restricted to single grapheme–phoneme correspondences and allows quick access to the linguistic characteristics of words. According to this model, routes can be activated in parallel (Taylor, Rastle, & Davis, 2013).

In addition to good phonological and orthographic skills, visual skills are needed to facilitate the analysis of the printed code. Specifically, reading through sublexical strategies that involves the selection of graphemes is based on visual-attentional automation processes. To read new words through letter–sound conversion (i.e., phonological route), the reader must be able to segment the fixed information, which involves a change in attentional focus. Fast serial coding allows integration between graphemes—and phonemes and automatic building of sublexical representations (i.e., lexical and sublexical route). Rapid serial coding treats letters as separate parts and allows the formation of visual forms of words (Bellocchi, Muneaux, Bastien-Toniazzo, & Ducrot, 2013).

COMPREHENSION

As previously mentioned, there is a strong relationship between comprehending spoken language and comprehending written language. Thus, comprehension is one of the processes that comes close to the objective of reading: comprehension, interpretation, and retention of the information presented visually (Cabral, 1986; Perfetti, Landi, & Oakhill, 2005).

At the beginning of literacy, this relationship is small since comprehension is limited because cognitive processes are focused on decoding

and identifying words (word recognition). As the reader becomes more proficient, the relationship between reading comprehension and listening comprehension increases, since comprehension is no longer limited by aspects of word recognition (Perfetti et al., 2005).

The basis of the texts is built by the propositions (nouns and predicates) that constitute the sentences. Therefore, the mental models of the text must also be created from the propositions, as well as inferences (Perfetti et al., 2005).

The comprehension process during reading can be described in five steps. The first step involves the identification of the basic units of meaning in each sentence (proposition). The second step involves the apprehension of how each constituent unit of proposition is organized in the phrases (i.e., agents, target, instrument). The third step involves an understanding of the contextual meaning of words, excluding conflicting meanings as in ambiguities, and extracting new meanings in new words and in already known words. The fourth step involves making relations between the different units of the inter- and intra-sentence text and applying grammatical rules already known. Finally, the fifth step involves making inferences about the text, making the text read structured, and extracting central ideas from it (Cabral, 1986).

Comprehension involves processes of creating mental representations of the text, which occurs at multiple linguistic levels: word level (lexical processes), sentence levels (syntactic processes) and text level. In addition, comprehension depends on word identification, parsing, referential mapping, inferential processes, and conceptual knowledge

processes. Finally, factors important for comprehension are sensitivity to the structure of the story (i.e., type of text: narrative, descriptive, etc.), ability to make inferences, and comprehension monitoring (Perfetti et al., 2005).

FLUENCY

Fluency is the ability to read texts articulately, quickly, effortlessly, automatically, and accurately. Reading fluently involves direct and automatic phonemic decoding and effective word recognition. Thus, fluency is developed from experience with reading and through the development of more efficient strategies that ensure reading speed and accuracy and facilitate understanding. Therefore, when reading is not fluent, the available attentional resources are directed to decoding and identifying words correctly, impairing the understanding of the material read (Handler & Fierson, 2011).

According to the simple view of reading (Protopapas et al., 2013, 2012), fluency is an essential skill for understanding the read material since it is one of the skills present in the component dependent on the written material. On the other hand, Adlof, Catts, and Little (2006) obtained significant results in relation to the independent contribution of fluency to the comprehension of material, which suggests that fluency is independent of word recognition and auditory and oral comprehension. According to this view, students in the literacy phase use more efforts for word recognition, that is, when they are in a more advanced stage of reading, when they are able to recognize words more quickly

(i.e., with more fluency), they start to direct cognitive resources to the comprehension processes. Thus, competent reading involves decoding, visual recognition, fluency, and comprehension. Therefore, it is essential to identify the predictive factors for competent reading.

Finally, reading is a complex skill that requires the development of several underlying skills. In addition, it is a skill of great importance for the development of learning, as well as for social development. However, most children have some reading difficulties. One of the impaired skills in children with reading difficulties is PA. However, when PA is preserved, RAN can explain the difficulties in the development of reading (Siddaiah & Padakannaya, 2015).

RAPID AUTOMATIZED NAMING AND READING

RAN is the ability to name a series of symbols, alphanumeric or not, as quickly as possible (Wakamiya et al., 2011; Wolf & Denckla, 2005). It is the cognitive ability that involves integrating visual and verbal information as quickly as possible (Norton & Wolf, 2012).

The first studies that described RAN tasks were related to the investigation of alexia, in which there are difficulties integrating visual and verbal processes. Norman Geschwind described these difficulties for the first time in 1965 in patients who had difficulties mainly in naming colors. Subsequently, neurologist Martha Denckla, inspired by Geschwind's studies, sought to further investigate the relationship between RAN and dyslexia (Norton & Wolf, 2012). Dyslexia is a neurodevelopmental learning disability characterized by a specific and persistent deficit in the ac-

quisition of reading and spelling skills that cannot be explained by deficits in other cognitive abilities, insufficient educational opportunities, or inappropriate literacy instruction (American Psychiatric Association, 2014). Thus, in 1976, Denckla and Rudel developed RAN as a consistent paradigm that involves assessing the ability to read fluency. The visual stimuli used for evaluation were letters, numbers, objects, or colors. The stimuli were presented in linear sequences, just as they occur in the reading of texts (Wolf & Denckla, 2005).

During quick assignment tasks, the integration of attentional, linguistic, perceptual, and motor processes occurs (Wakamiya et al., 2011). The steps of processing information for such a task first involve visual processing for detecting stimuli characteristics and visual discrimination of the stimuli. After this step, it is necessary to integrate visual characteristics with the previously stored orthographic, numerical, or imagery representations, depending on the type of stimuli presented. Later, it is necessary to access the stored phonological representations necessary for the correct identification of the symbol's name. Finally, there is the access and retrieval of the phonological record and subsequent activation and integration of semantic and conceptual information with all other information. This final step helps in understanding the information so that, during the naming task, the meaning can be accessed, enabling the comprehension of what is being seen (Aguilar-Vafaie, Safarpour, Khosrojavid, & Afruz, 2012; Wolf & Denckla, 2005).

RAN is, therefore, a cascading skill involving visual processes, phonological and orthographic mapping, and articulatory planning (Silva,

Mecca, & Macedo, 2018). Different items can be processed simultaneously in different steps. When automation of early reading skills occurs, parallel processing of the observed items occurs. Thus, items can be processed automatically while executive control monitors the process through specific phases. Consequently, RAN can help to identify strategies and development in the reading of different words that begin with the series processing (decoding and grapheme-phoneme conversion by phonologic route) and progresses to the reading of the word as a whole (direct lexical access by lexical route). The processes involved in naming tasks develop and change in the course of learning. These changes involve the ability to process several items at the same time in a cascade and to process information within words (letters and syllables) and between words (Protopapas et al., 2013).

Therefore, RAN involves and depends on attentional processes and components, detection of characteristics, visual discrimination and identification patterns, integration of characteristics with orthographic and phonological representations, access to the phonological labels, activation and integration of semantic information, and articulation (Siddaiah & Padakannaya, 2015).

RAN skills develop according to age, and the naming speed increases over time. Thus, there is greater skill development at early schooling ages, when the time for naming is even greater. However, as schooling and reading progress, the time for automatic naming decreases. Regarding accuracy, children 7 years of age make more errors than those of 15 years of age. Finally, studies indicate that RAN is a skill that may not in-

volve a single type of processing such as phonological, speed, or memory, but may be a complex process that requires multiple skills, such as attention, access to the phonological code, and activation and integration of semantic and conceptual information (Albuquerque & Simões, 2010).

Different studies point to the relationship between RAN and good reading performance (Silva, Mecca, & Macedo, 2018; Wolf & Denckla, 2005). RAN is relevant, both for phonological and orthographic processing in reading. With regard to the development of reading strategies, and based on the cognitive models presented, RAN is important for orthographic processing and for direct lexical access since in grapheme–phoneme decoding it becomes necessary to access phonological and graphic codes, and the faster and more efficient this access is, the more successful the person will be in reading. In addition, it is noted that proficient readers make use of the two reading routes.

An important measure that also correlates with RAN and reading fluency is vocabulary. Words learned earlier are more quickly named than those learned later, thus facilitating lexical access. As a result, vocabulary is a psycholinguistic variable that influences speed and accuracy in naming as well as lexical processing skills (Palmer & Havelka, 2010; Wakamiya et al., 2011).

Studies on naming are important not only for understanding reading, but also for assessing individuals with attention deficits (Alves et al., 2016; Ryan et al., 2017; Whipple & Nelson, 2016). Specifically, RAN is used to assist in the assessment of attention since it is a measure of verbal naming speed and processing speed that may be impaired in individ-

uals with attention deficits. Thus, children with inattention have lower speed in naming tasks (Arnett et al., 2012).

To conclude, since RAN measures have multiple components, they can be used in different contexts and for different purposes.

PREDICTIVE VALUES OF RAN AND PA FOR READING

Analyses of different types of writing have shown that different spelling systems have different linguistic predictors. Specifically, there are differences in the predictive values for different linguistic systems for phonological awareness and naming (Furnes & Samuelsson, 2011; Georgiou, Papadopoulos, Fella, & Parrila, 2012; Georgiou, Parrila, & Papadopoulos, 2008; Pae, Sevcik, & Morris, 2010).

Studies have sought to analyze the predictive effects of RAN and PA on the development of reading. Thus, RAN has been correlated with reading comprehension and fluency. PA, on the other hand, is a measure that has been correlated with the subsequent ability to read accurately and with phonological decoding, helping the conversion of visual symbols to their sounds (Bowers, 1995; Cardoso-Martins & Pennington, 2001; Torgesen, Wagner, Rashotte, Burgess, & Hecht, 1997).

More specifically, in relation to reading isolated words and pseudowords, studies indicate contributions of different cognitive skills with PA, phonological memory, and alphanumeric RAN being the best predictors, depending on the measure and the type of linguistic unit considered. However, in the course of schooling and the development of reading skills, the predictive values of the two skills (RAN and PA)

change. Thus, in the first two years of literacy, RAN is a better predictor of tasks involving orthographic information, while PA is a better predictor of reading pseudowords (González-Valenzuela, Díaz-Giráldez, & López- Montiel, 2016; Manis, Seidenberg, & Doi, 1999).

Several studies focused on the different contributions of PA and RAN to reading and writing. Results showed that both skills contribute substantially to fluency in all six primary school years. However, the relationship between PA and word reading fluency decreases as a function of reading experience, whereas the relationship between RAN and word reading fluency gradually increases (Vaessen & Blomert, 2010). In the case of writing, PA is associated with accuracy of dictation, while RAN is correlated with accuracy of dictation and fluency in writing (Albuquerque, 2012; Georgiou, Tziraki, Manolitsis, & Fella, 2013; Ibrahim, 2015). In addition, divergent results were obtained in studies of different languages, indicating that there could be differences between the predictive strengths of PA and RAN for reading, depending on linguistic specificities (Park & Uno, 2015). For example, a study by Furnes and Samuelsson (2011) suggests that RAN is more predictive for early reading skills than PA, as RAN is not affected by orthographic regularity.

RAN can, therefore, contribute to and predict the measures of word, text, and pseudoword reading and reading comprehension with greater predictive value for word and text reading. This predictive value depends on orthographic regularity and a student's grade or school level(Araújo, Reis, Petersson, & Faísca, 2015). In order to verify the predictive effect of RAN throughout the school years, several longitudinal studies were conducted.

These studies showed that RAN is a predictor of reading speed independent of previous reading skills, whereas phonological skills predict spelling aspects only when previous reading skills are controlled. Thus, RAN is an independent predictor of previous reading knowledge (Babayigit & Stainthorp, 2010). In addition, vowel RAN and digit RAN are found to be good predictors of reading accuracy and speed (Hornung, Martin, & Fayol, 2017).

RAN tests represent one of the two best predictors for reading difficulties, along with PA tests. This predictive ability—and the fact that the tests are simple, fun, and quick to administer—makes using naming tests, such as RAN, in any battery or diagnostic assessment of oral or written language more relevant. Naming speed tests, particularly for letters and numbers, provide one of the best measures for differentiating between good and bad readers. This is because both quick naming and reading involve visual recognition of stimuli and access to their phonological representation. Thus, naming tests are of great importance to better understanding of individuals' reading skills (Wolf & Denckla, 2005). In fact, tests that assess RAN are used in several countries as diagnostic tools for reading difficulties (Kirby et al., 2010), as they have been used for this purpose since their development. In their original study, Denckla and Rudel (1976) already showed differences in naming speed between groups of children with learning difficulties and control children (Silva et al., 2018).

Reading ability involves a series of attributions in cognitive and language terms, and therefore, evaluating reading performance is a complex and multivariate process (Evans, Floyd, McGrew, & Leforgee, 2001).

Understanding and studying the prediction of reading and writing is, however, extremely important for the identification of early reading difficulties. Currently, there is a high number of neuroscience studies in search of neural predictors of performance in reading and writing, as well as early identification of the processes and mechanisms that encompass them, which would enable a more effective intervention and guarantee good reading performance during development.

REFERENCES

- Aaron, P. G., Joshi, R. M., Gooden, R., & Bentum, K. E. (2008). Diagnosis and treatment of reading disabilities based on the component model of reading. *Journal of Learning Disabilities*, 41(1), 67–84. <https://doi.org/10.1177/0022219407310838>
- Adlof, S. M., Catts, H. W., & Little, T. D. (2006). Should the simple view of reading include a fluency component? *Reading and Writing*, 19(9), 933–958. <https://doi.org/10.1007/s11145-006-9024-z>
- Aguilar-Vafaie, M. E., Safarpour, N., Khosrojavid, M., & Afruz, G. A. (2012). A comparative study of rapid naming and working memory as predictors of word recognition and reading comprehension in relation to phonological awareness in Iranian dyslexic and normal children. *Procedia - Social and Behavioral Sciences*, 32, 14–21. <https://doi.org/https://doi.org/10.1016/j.sbspro.2012.01.003>
- Albuquerque, C. P. (2012). Rapid naming contributions to reading and writing acquisition of European Portuguese. *Reading and Writing*, 25(4), 775–797. <https://doi.org/10.1007/s11145-011-9299-6>
- Albuquerque, C. P., & Simões, M. R. (2010). Rapid naming tests: Developmental course and relations with neuropsychological measures. *The Spanish Journal of Psychology*, 13(1), 88–100. <https://doi.org/10.1017/S1138741600003693>
- Alves, L. M., Siqueira, C. M., Ferreira, M. do C. M., Alves, J. F. M., Lodi, D. F., Bicalho, L., & Celeste, L. C. (2016). Rapid naming in Brazilian students with dyslexia and attention deficit hyperactivity disorder. *Frontiers in Psychology*, 7(JAN). <https://doi.org/10.3389/fpsyg.2016.00021>

- Araújo, S., Reis, A., Petersson, K. M., & Faísca, L. (2015). Rapid automatized naming and reading performance: A meta-analysis. *Journal of Educational Psychology*, 107(3), 868–883. <https://doi.org/10.1037/edu0000006>
- Arnett, A. B., Pennington, B. F., Willcutt, E., Dmitrieva, J., Byrne, B., Samuelsson, S., & Olson, R. K. (2012). A cross-lagged model of the development of ADHD inattention symptoms and rapid naming speed. *Journal of Abnormal Child Psychology*, 40(8), 1313–1326. <https://doi.org/10.1007/s10802-012-9644-5>
- Babayigit, S., & Stainthorp, R. (2010). Component processes of early reading, spelling, and narrative writing skills in Turkish: a longitudinal study. *Reading and Writing*, 23(5), 539–568. <https://doi.org/10.1007/s11145-009-9173-y>
- Bellocchi, S., Muneaux, M., Bastien-Toniazzo, M., & Ducrot, S. (2013). I can read it in your eyes: What eye movements tell us about visuo-attentional processes in developmental dyslexia. *Research in Developmental Disabilities*, 34(1), 452–460. <https://doi.org/10.1016/j.ridd.2012.09.002>
- Bowers, P. G. (1995). Tracing symbol naming speed's unique contributions to reading disabilities over time. *Reading and Writing*, 7(2), 189–216. <https://doi.org/10.1007/BF01027185>
- Cabral, L. S. (1986). Processos psicolinguísticos de leitura e escrita (Psycholinguistic processes of reading and writing). *Anais Do Seminário as Ciências Da Linguagem e a Formação Do Leitor*, 19(1).
- Cardoso-Martins, C., & Pennington, B. F. (2001). Qual é a contribuição da nomeação seriada rápida para a habilidade de leitura e escrita?: Evidência de crianças e adolescentes com e sem dificuldades de leitura (What is the contribution of quick serial naming to reading and writing skills?: Evidence from children and adolescents with and without reading difficulties). *Psicologia: Reflexão e Crítica*, 14(2), 387–397. <https://doi.org/10.1590/S0102-79722001000200013>
- Denckla, M. B., & Rudel, R. G. (1976). Rapid 'automatized' naming (R.A.N.): Dyslexia differentiated from other learning disabilities. *Neuropsychologia*, 14(4), 471–479. [https://doi.org/10.1016/0028-3932\(76\)90075-0](https://doi.org/10.1016/0028-3932(76)90075-0)
- Ellis, A. W., Young, A. W., & Anderson, C. (1988). Modes of word recognition in the left and right cerebral hemispheres. *Brain and Language*, 35(2), 254–273. [https://doi.org/10.1016/0093-934X\(88\)90111-3](https://doi.org/10.1016/0093-934X(88)90111-3)

Evans, J. J., Floyd, R. G., McGrew, K. S., & Leforgee, M. H. (2001). The relations between measures of Cattell-Horn-Carroll (CHC) cognitive abilities and reading achievement during childhood and adolescence. *School Psychology Review*, 31(2), 246–262.

Furnes, B., & Samuelsson, S. (2011). Phonological awareness and rapid automatized naming predicting early development in reading and spelling: Results from a cross-linguistic longitudinal study. *Learning and Individual Differences*, 21(1), 85–95. <https://doi.org/10.1016/j.lindif.2010.10.005>

Georgiou, G. K., Papadopoulos, T. C., Fella, A., & Parrila, R. (2012). Rapid naming speed components and reading development in a consistent orthography. *Journal of Experimental Child Psychology*, 112(1), 1–17. <https://doi.org/10.1016/j.jecp.2011.11.006>

Georgiou, G. K., Parrila, R., & Papadopoulos, T. C. (2008). Predictors of word decoding and reading fluency across languages varying in orthographic consistency. *Journal of Educational Psychology*, 100(3), 566–580. <https://doi.org/10.1037/0022-0663.100.3.566>

Georgiou, G. K., Tziraki, N., Manolitsis, G., & Fella, A. (2013). Is rapid automatized naming related to reading and mathematics for the same reason(s)? A follow-up study from kindergarten to Grade 1. *Journal of Experimental Child Psychology*, 115(3), 481–496. <https://doi.org/10.1016/j.jecp.2013.01.004>

González-Valenzuela, M. J., Díaz-Giráldez, F., & López-Montiel, M. D. (2016). Cognitive predictors of word and pseudoword reading in Spanish first-grade children. *Frontiers in Psychology*, 7(MAY), 1–12. <https://doi.org/10.3389/fpsyg.2016.00774>

Gough, P. B., & Tunmer, W. E. (1986). Decoding, reading, and reading disability. *Remedial and Special Education*, 7(1), 6–10. <https://doi.org/10.1177/074193258600700104>

Handler, S. M., & Fierson, W. M. (2011). Learning disabilities, dyslexia, and vision. *Pediatrics*, 127(3), e818–e856. <https://doi.org/10.1542/peds.2010-3670>

Hornung, C., Martin, R., & Fayol, M. (2017). The power of vowels: Contributions of vowel, consonant and digit RAN to clinical approaches in reading development. *Learning and Individual Differences*, 57(August 2016), 85–102. <https://doi.org/10.1016/j.lindif.2017.06.006>

- Ibrahim, R. (2015). How does rapid automatized naming (RAN) correlate with measures of reading fluency in Arabic. *Psychology*, 06(03), 269–277. <https://doi.org/10.4236/psych.2015.63027>
- Kirby, J. R., Georgiou, G. K., Martinussen, R., Parrila, R., Bowers, P., & Landerl, K. (2010). Naming speed and reading: From prediction to instruction. *Reading Research Quarterly*, 45(3), 341–362. <https://doi.org/10.1598/RRQ.45.3.4>
- Manis, F. R., Seidenberg, M. S., & Doi, L. M. (1999). See Dick RAN: Rapid naming and the longitudinal prediction of reading subskills in first and second graders. *Scientific Studies of Reading*, 3(2), 129–157. https://doi.org/10.1207/s1532799xssr0302_3
- Norton, E. S., & Wolf, M. (2012). Rapid automatized naming (RAN) and reading fluency: Implications for understanding and treatment of reading disabilities. *Annual Review of Psychology*, 63(1), 427–452. <https://doi.org/10.1146/annurev-psych-120710-100431>
- Pae, H. K., Sevcik, R. A., & Morris, R. D. (2010). Cross-language correlates in phonological awareness and naming speed: evidence from deep and shallow orthographies. *Journal of Research in Reading*, 33(4), 374–391. <https://doi.org/10.1111/j.1467-9817.2009.01417.x>
- Palmer, S. D., & Havelka, J. (2010). Age of acquisition effects in vocabulary learning. *Acta Psychologica*, 135(3), 310–315. <https://doi.org/10.1016/j.actpsy.2010.08.002>
- Park, H.-R., & Uno, A. (2015). Cognitive abilities underlying reading accuracy, fluency and spelling acquisition in Korean Hangul learners from grades 1 to 4: A cross-sectional study. *Dyslexia*, 21(3), 235–253. <https://doi.org/10.1002/dys.1500>
- Pazeto, T. de C. B., León, C. B. R., & Seabra, A. G. (2017). Avaliação de habilidades preliminares de leitura e escrita no início da alfabetização (Assessment of preliminary reading and writing skills at the beginning of literacy). *Revista Psicopedagogia*, 34(104), 137–147. Retrieved from http://pepsic.bvsalud.org/scielo.php?script=sci_abstract&pid=S0103-84862017000200004&lng=pt&nrm=iso
- Perfetti, C. A., Landi, N., & Oakhill, J. (2005). The acquisition of reading comprehension skill. In M. J. Snowling & C. Hulme (Eds.), *The science of reading: a handbook*. <https://doi.org/10.1002/9780470757642>
- Protopapas, A., Mouzaki, A., Sideridis, G. D., Kotsolakou, A., & Simos, P. G. (2013). The role of vocabulary in the context of the simple view of reading. *Reading &*

Writing Quarterly, 29(2), 168–202. <https://doi.org/10.1080/10573569.2013.758569>

Protopapas, A., Simos, P. G., Sideridis, G. D., & Mouzaki, A. (2012). The components of the simple view of reading: A confirmatory factor analysis. *Reading Psychology*, 33(3), 217–240. <https://doi.org/10.1080/02702711.2010.507626>

Ryan, M., Jacobson, L. A., Hague, C., Bellows, A., Denckla, M. B., & Mahone, E. M. (2017). Rapid automatized naming (RAN) in children with ADHD: An ex-Gaussian analysis. *Child Neuropsychology*, 23(5), 571–587. <https://doi.org/10.1080/09297049.2016.1172560>

Seabra, A. G. (2011). A natureza componencial da leitura (The component nature of Reading). In F. C. Capovilla (Ed.), *Transtornos de aprendizagem, 2: da análise laboratorial e da reabilitação clínica para as políticas públicas de prevenção pela via da educação*. São Paulo: Memnom.

Siddaiah, A., & Padakannaya, P. (2015). Rapid automatized naming and reading: A review. *Psychological Studies*, 60(1), 70–76. <https://doi.org/10.1007/s12646-014-0280-8>

Silva, P. B. da, Mecca, T., & Macedo, E. C. de. (2018). *TENA Teste de nomeação automática* (1st ed.). São Paulo: Hogrefe CETEPP.

Taylor, J. S. H., Rastle, K., & Davis, M. H. (2013). Can cognitive models explain brain activation during word and pseudoword reading? A meta-analysis of 36 neuroimaging studies. *Psychological Bulletin*, 139(4), 766–791. <https://doi.org/10.1037/a0030266>

Torgesen, J. K., Wagner, R. K., Rashotte, C. A., Burgess, S., & Hecht, S. (1997). Contributions of phonological awareness and rapid automatic naming ability to the growth of word-reading skills in second-to fifth-grade children. *Scientific Studies of Reading*, 1(2), 161–185. https://doi.org/10.1207/s1532799xssr0102_4

Vaessen, A., & Blomert, L. (2010). Long-term cognitive dynamics of fluent reading development. *Journal of Experimental Child Psychology*, 105(3), 213–231. <https://doi.org/10.1016/j.jecp.2009.11.005>

Wakamiya, E., Okumura, T., Nakanishi, M., Takeshita, T., Mizuta, M., Kurimoto, N., & Tamai, H. (2011). Effects of sequential and discrete rapid naming on reading in Japanese children with reading difficulty. *Brain and Development*, 33(6), 487–493. <https://doi.org/10.1016/j.braindev.2010.12.008>

- Whipple, B. D., & Nelson, J. M. (2016). Naming speed of adolescents and young adults with attention deficit hyperactivity disorder: Differences in alphanumeric versus color/object naming. *Archives of Clinical Neuropsychology*, 31(1), 66–78. <https://doi.org/10.1093/arclin/acv061>
- Wolf, M., & Denckla, M. B. (2005). *Rapid Automatized naming and rapid alternating test*. Texas: Pro-ed.
- Silva, P. B. da, Mecca, T., & Macedo, E. C. de. (2018). *TENA Teste de nomeação automática* (1st ed.). São Paulo: Hogrefe CETEPP.
- Taylor, J. S. H., Rastle, K., & Davis, M. H. (2013). Can cognitive models explain brain activation during word and pseudoword reading? A meta-analysis of 36 neuroimaging studies. *Psychological Bulletin*, 139(4), 766–791. <https://doi.org/10.1037/a0030266>

CHAPTER 9

The non negotiables of inclusive education

Fernanda T. Orsati

Christine E. Ashby

Inclusion has become a popular buzzword in education. Many schools and programs claim inclusivity without considering the actual work that needs to be done to operationalize those aims, particularly for students with disabilities. This chapter will discuss factors that need to be in place to foster effective and meaningful inclusive classrooms and schools. The authors will draw from the literature policies, structures, strategies, and supports that are necessary for all students to be successfully included in diverse schools and classrooms. We consider the implementation of inclusive education a human right, promoting equality in access to education for all individuals. Besides being a right, it is also proven to improve outcomes for all students. However, when implemented poorly, without the necessary supports and structures in place, inclusive schooling ends up being ineffective and justifiably open for criticism. In this chapter, we outline practices that need to be in place to ensure that the schooling is really inclusive and sustainable.

Inclusive education is regulated by law in several countries. For Brazilian schools we follow the Special Education National Policy in an Inclu-

sive Education perspective (Brasil, 2008); in the United States, services for students with disabilities are regulated through the Individuals with Disability Education Act - IDEA (U.S. Department of Education, 1997). One of the key components of IDEA is a requirement for education in the least restrictive environment, and in the Brazilian law it reads the privileging of inclusive environments.

There is a considerable body of evidence to support the effectiveness of this inclusive educational model for all children (Causton, Theoharis, Orsati & Cosier, 2011; Cosier, Causton-Theoharis & Theoharis, 2013; Dessemontet, Bless & Morin, 2012; Dessemontet & Bless, 2013; Mitchell, 2014). Mitchell (2014) attends to the importance of a full implementation of inclusive education with the following core elements: vision, placement, adapted curriculum, adapted assessment and adapted teaching, access and acceptance, support, resources and leadership. For inclusive education to work, it needs to be viewed as part of a system that extends from the classroom, to the broader society.

Different measures can be used to describe effectiveness in inclusive education. A qualitative study that assessed 1,300 students from six to nine years old, described a correlation between time spent in general education classroom and performance in English and Math (Cosier, Causton-Theoharis & Theoharis, 2013). Put simply, the more time students spend exposed to and engaged in general education content, curriculum and experiences, the more they will learn, regardless of their disabilities. With the right special education services, aids and support, general education does not fail to deliver.

In 2012, Dessemontet, Bless and Morin followed 34 students with intellectual disabilities included in general education with individualized supports, and 34 students in the control group, who attended school in a special placement. The authors conclude that inclusion of students with complex needs is not only possible, but that the students with intellectual disabilities in general education also had a better performance and progression than their peers in a special school. Furthermore, in 2011, a group of researchers visited and described the experiences of segregated special education classrooms in the US and concluded that there is nothing “special” about those classrooms, and that they did not deliver on the promises a placement in separate schools rely on (Caus-
ton-Theoharis, Theoharis, Orsati, & Cosier, 2011). For example, they do not offer a sense of community to the students with disabilities, they are not distraction free - on the contrary, they are very distracting because of the diverse students’ needs, they do not outline specialized and individualized curriculum and instruction, nor provide adequate behavioral supports. So, the argument that special education is a better placement due to what it can offer students with disabilities, is inherently flawed. Lastly, inclusive education does not interfere negatively with the learning experience of the typically developing students. Dessemontet and Bless (2013) did not find any differences in the performance of students without disabilities, being the ones with low, average or high abilities between classes where they had students with and without intellectual disabilities.

Given this foundation in regulation and research, we propose the following key elements of quality inclusive education. In the following

sections, we introduce larger themes, including shifts in philosophy, school structures, classroom structures and supports, and finally teacher training. These are only a few of the important moving parts that need to be articulated to create an actual inclusive school. This chapter does not aim to explicate all possible elements, but to discuss what is minimally needed, what is non-negotiable in inclusive education.

SHIFTS IN PHILOSOPHY

The philosophy of inclusive education needs to precede the implementation of inclusive practices. Thus, one large category that is certainly a blueprint for a school to be inclusive is to construct a belief system for inclusion. All staff, as well as parents and students themselves, need a clearly articulated and pervasive shared vision for inclusion that encompasses every facet of the school program and policies. For example, talking about the one inclusive classroom in each grade already demonstrates that a commitment to inclusion is not a schoolwide vision, but a place where you locate the students labeled as having a disability. A philosophy does not stand alone to promote inclusive schools, but practices and funding do not either if they cannot come alongside with the mindset to support it. We recommend the generation of a school wide inclusive vision statement that becomes a touchstone for decision making. Whenever decisions about policies or practices are being considered, come back to that non-negotiable vision and ask if the decision you are considering moves you closer to or further from that vision. A key element of an inclusive vision is a commitment to presuming and constructing competence.

Teachers need to presume that all students are interested in learning and are capable of far more than they are demonstrating using the currently available resources (Biklen, 2006; Jorgensen, McSheehan, & Sonnenmeir, 2007). In other words, when students with disabilities (or any students) are not demonstrating success, we should not assume that the difficulty lies within the child alone, but within the interaction of that child and their academic and social world. A presumption of competence places the onus of responsibility on the teaching staff to create a context that builds on student strengths' and supports engagement and learning. If we presume that the child is incapable of learning and participating, the creative problem solving stops. We also have to recognize that not all students are able to demonstrate competence in the same ways. Competence is commonly assessed in how students respond to a question, how they bring homework completed, or even how they socialize with peers. Equating current performance with future possibility limits opportunities for growth.

A students' competence is not a given, but it is constructed over the year - or over many years. Teachers have a lot of influence, for example in how students' behavior problems get constructed as so (Orsati & Causton-Theoharis, 2013). Conversely, teachers can also be responsible for actively constructing student competence (Ashby, Woodfield & Delia, 2016). For example, if you have a student in your class that does not use speech as a reliable form of communication, basing your assumptions of her or his understanding and competence through activities requiring verbal output will never allow you to access their knowledge or allow

the student a means to engage with your instruction. The presumption and construction of competence is a process that needs to be conveyed everyday for the student and their colleagues, in their access to participation, materials, curriculum, and knowledge as a whole. When you believe all students are capable of learning, you, as a teacher, will create opportunities for success, for them to engage with materials, interact with peers, for performance on assessments, and connection with content. Therefore, constructing students' competence is one of the most important steps a teacher can take for the success of inclusive education. We will elaborate on practices that support a construction of competence approach in a later section of this chapter.

Just as teachers need to presume competence, they also need to presume a desire for connection and social engagement. "Inclusive education, therefore, demands more than presence. It demands engagement and participation - belonging in action. But that expectation of participation requires a presumption of competence and potential" (Ashby & Woodfield, 2019, p, 154). All students need to feel that they belong, that they have a positive relationship with teachers so that they engage proportionally and, consequently it enhances learning (Miles & Stipek, 2006; White, 2013). For that to happen, teachers need to be close to the students and show them that individual differences are welcomed in the classroom and in the school, not just accepted. Students with different abilities and from different backgrounds need to feel a sense of belonging to their group and environment. In addition, for that to happen, all students' perspectives need to be reflected in materials, curriculum and

classroom participation. Besides that, a person living with a disability has their own perspective on their needs and accommodations that should also be taken into account when planning and interacting with them.

All these elements are part of the school and classroom climate, which entails a positive, motivating and safe context that needs to be promoted. Teachers need to create an emotionally safe environment and establish positive and consistent relationships, in which all students can trust (Mitchell, 2014). When a student trusts the educator and feels safe in their school and classroom, they are prone to take more risks and try harder without a fear of failing. In addition, when they have a good relationship, they tend to display more socially positive and agreeable behaviors towards the teacher, trying to please and impress them (Miles & Stipek, 2006). In a school where students feel they are part of and teachers are on their side, they are ready to collaborate and grow together with them.

Finally, setting high and realistic expectations is essential so that students understand that there is a requirement for their behavior and academic performance, and they are believed to be capable of achieving it. It is not redundant to argue that we need to hold high expectations for everyone, despite their current level of engagement and performance. The more you realistically expect, the more a student raises to meet those expectations. Research shows that students are aware of teachers' expectations and that may also influence their performance (Schiavoni & Martinelli, 2005). This is related to the construction of competence, because if you expect less from students with disabilities, you expose students to less general education content and, in consequence,

they do not perform as well as students in general education (Cosier, Causton-Theoharis & Theoharis, 2013).

From a social model perspective, we should perceive student challenges as a result of the adequacy of the opportunities provided, rather than on an inherent student deficit. The burden is on adults to provide instruction, materials, activities and supports that enable students to perform academically and socially. When teachers provide challenging but achievable goals for students to work towards, students can be more engaged with the material and as a consequence feel more motivated to learn.

SCHOOL STRUCTURES

In order for schools to be truly inclusive the structures, policies, and practices need to support its philosophy. Inclusive education is not a place, it is a portable service to be delivered in all our schools. Rather than creating special places for students with disabilities, services can be brought to them in general education spaces. Different elements need to be in place so that the structure can allow for inclusive practices to take place; without those, even with a clearly articulated and inclusive philosophy there is no foundation for the realization of inclusion. Mitchell (2014) writes that primarily we need to provide a physical environment that enables learning, defending that something as basic as the internal structure of the school needs to be planned and developed purposefully because the quality of the space is one important variable to improve student engagement and learning.

Furthermore, there are necessary, but not sufficient, requirements for quality inclusive practice. First, it is important to maintain, as closely as possible, the principle of natural proportions. This states that the makeup schools and individual classrooms should mirror as closely as possible the demographic makeup of students in the general population (Causton & Tracy-Bronson, 2015). For example, in Brazil, we estimate the percentage of individuals with disabilities in the general population to be between 7% and 24% (IBGE, 2010). This number varies depending on the criteria established to define the disability or social functioning. Therefore, in a classroom with 30 students, we would expect to see around 10 to 20% of students with a disability, in this case from 3 to 5 students. When the ratio of students with disabilities is disproportionate, that can impact the quality of service delivery and teacher attention, with significant impacts on educational outcomes.

A second parameter to follow in order to guarantee quality, is the teacher student ratio. Research shows that having a controlled and low teacher-student ratio is one of the most important variables to promote quality in education, and surely in inclusive education. For lower grades the ratio is lower, as well, because of the various needs of the students. For higher grades, we can afford to have fewer teachers per student, however, needed students should have a para-professional for extra support when needed. Overall, having lower teacher-student ratios is found to enhance quality in education and help create conditions to facilitate better outcomes for students (OECD, 2019a; OECD, 2019b).

Administration support is key, not only for school climate as described before, but also for support in diverse practices. A socially just leadership, which is ready for the diverse student body, needs to achieve some key standards. Scanlan and Theoharis (2015) cite the importance of the administration in developing a school culture that is inclusive, where students have access to core curriculum and feel integral members of the school community. In addition, they outline the importance of ensuring effective management of the organization, operations and resources for a safe, efficient and effective learning environment.

Beyond the natural proportions and staffing ratio discussed above, necessary resources include in service training and paid planning time for teachers, for example. A well-executed class, in which all students are engaged and learning, is only made possible with careful planning. Therefore, the school leadership needs to recognize that teacher time outside of the classroom needs to be pre scheduled and paid. When a teacher is assigned with a full schedule of classroom time, they are so busy that they are not afforded time to research, collaborate with fellow teachers, and plan activities for all their students. This is a common practice in Brazilian schools, where it can be even worse with educators holding multiple jobs in different schools in the different periods to complement their salaries to a livable wage. Therefore, it becomes clear that students, particularly those with identified disabilities, may not be assisted in that class. This will only create and exacerbate a gap of inclusion of these students in their engagement with materials and peers, and as a consequence in performance.

CLASSROOM STRUCTURES AND SUPPORTS

When we consider classroom structures' and instructional supports for inclusive education, this includes teaching models that employ co-teaching, integrated supports with other specialists, strategies for student participation and engagement, access to communication and provision of positive behavior supports are key elements. Co-teaching models require the collaborative work between two or more educators, most commonly a special educator and a general educator, so that the classes are taught by these two professionals with their different sets of complementary expertise (Friend & Bursuck, 2009). There are multiple co-teaching models outlined in the literature, ranging from one teacher providing direction instruction while the other provides student support to station teaching to full collaboration where both teachers are equally responsible for planning, delivery and assessment of learning. Implementation of specific collaborative models is often dependent on the skill and experience of the teaching team as well as specific demands of the content or lesson. However, regardless of the model, co-teaching needs the support of school leadership. In addition, the need for ongoing and adequate amount of planning time together, co-planning, so that the strategies and students' supports are well supported in the research literature (Mitchell, 2014; Causton & Tracy-Bronson, 2015). Co-teaching, for example, is particularly relevant in middle school, for example, where the specialized knowledge can be complemented by a teacher that understands more of students' behaviors and teaching pedagogies.

Besides collaboration between special and regular education teachers, inclusive schools rely on the support of other professionals that assist students in developing specific skills and/or provide indirect consultation with teachers on strategies and adaptations to promote student learning. This could include the involvement of a technology expert to problem solve on resources that improve the engagement of a student with motor issues or a speech therapist to support language and communication practices for the student and strategies for the classmates or teachers so that students can participate in class. The most common professionals with this role in schools are psychologists, speech pathologists, occupational therapists, physical therapists, and technology specialists, to name a few. Their participation depends on the students' individualized needs. This type of on-site school presence and support is not a common practice in Brazilian schools, but needs to be encouraged. These professionals can participate to complement teachers' knowledge, but not supplant it.

There is so much we are expecting from teachers in this inclusive schooling model, and the knowledge, practices and strategies implemented in the classroom can be supplemented with a consultation with a health specialist, for example, in order for specific student needs' to be supported. It is not an attempt to make schools what they are not, clinics, but an attempt to support all students' needs so they can be included in that school. In truly inclusive schools, integration of these supportive services benefits all students, not just those with identified special education needs.

In order to promote student learning, participation and engagement, different strategies are described as effective in inclusive schools, including individualized planning, adapted curriculum and/or materials, peer support and collaborative grouping. Individualized educational plans (IEP) are an essential gathering of information about the student that will help educators plan accordingly (Friend & Bursuck, 2009). Minimally, an IEP needs to identify current strengths and needs, identify priority goals and outline the services and supports necessary to address areas of need and engage meaningfully in content and curriculum. When educators plan the classroom and lessons with the individual students' needs and instructional goals in mind, we will be more successful in achieving them. Thus, once we have this individualized planning, and we know our students and their specific needs, we can adapt our curriculum and activities. For some students, we need to oversee the planned curriculum for the semester or year. Alternatively, we may not need to adapt the curriculum but the activities and strategies to access it. Besides thinking of how to structure the class so all students can learn, we can also aid the support for the student to engage in the proposed activity. Differentiation of instruction and materials is when students are working on similar topics but accessing it in different ways (Causton & Tracy-Bronson, 2015).

Instruction that is engaging and motivating is essential to enhance student learning (CAST, 2018). When we recruit students' interests, we can observe that they exhibit more sustainable effort and persistence, as well as self-regulation for learning (CAST, 2018). Universal design for

learning also outlines that supports for action and expression need also to be planned with the diverse learners in mind, and should include various modes for response and navigation to use of assistive technology. In addition, individualized support of another adult is ideal depending on the complexity of needs of the students to engage with the materials. This individualized support is also guaranteed by law in Brazil, but rarely applied in the practice. This aide or assistant can ensure that students have access, that they can respond and participate equally in class. Another type of support is peer support, which is when classmates are directly taught on strategies to support students with disabilities, so that individualized support can be delivered when needed when an adult is not available. This is a very applicable, acceptable and effective strategy, for higher grades, for example (Carter, Sisco, Melekoglu, & Kurkowski, 2007).

Heterogeneous classrooms are at the core of inclusive schooling. Purposeful grouping, with attention to specific interests, strengths and needs, is an intentional strategy that allows all the opportunity to complement each other's knowledge and abilities. The use of work stations is another way students can be separated in small collaborative groups to work on different tasks or different parts of a larger task. These models go beyond the whole class teaching that does not contemplate the learning styles of most students to promote more engagement and learning.

Communication is a human right and an essential resource that every student needs so to access learning and social engagement. Ashby,

Woodfield and Delia (2016) argue that all students deserve the assumption of a communicative interest and competence, to afford appropriate support for expression and context for learning. Therefore, the use of Alternative Augmentative Communicative (AAC) is imperative in inclusive schools for any students that cannot rely on reliable verbal speech, because we all need to have a voice so they can actually participate and engage with content, materials and classmates so that learning can actually take place for the student with complex communication needs. Supporting AAC users in the classroom requires proactive support such as increased wait time, reformatting activities to support participation, advance preparation and ensuring access to age- and context-appropriate vocabulary.

Successful inclusive classrooms also integrate positive behavior support. One of the predictors of inclusion is the presence of behavior issues, meaning that the first children to be excluded are the ones who present non-conforming behaviors. Understanding that all behaviors communicate a need, and this need is what to be addressed in order to support the student, then we will be successful in obtaining engaged behaviors. On the contrary, if we insist on dealing with symptoms, with the behavior and not its causes, we will be only developing remedies and not solutions. Preventive supports entail creating a positive climate, developing positive relationships with students and offering motivation are all paramount for the behaviors of students (Orsati, 2016). When you get to know your students, you can engage their interests, celebrate their successes, as well as learn to understand their underlying needs and

support the student and their behavior when challenges arise. In addition, when teachers identify the skills the students are lacking, they will be able to understand why they are behaving the way they are (Greene, 2008), and then support their behaviors and promote learning.

Just as not as all students will communicate in the same way, students need a variety of ways to access instruction. Teachers need to allow for and encourage multiple ways of engaging with content and demonstrating knowledge. Ableism is the uncritical assertion that particular ways of being and performing are preferable and that those desired standards of performance center a non-disabled experience (Hehir, 2002). In inclusive classrooms, we need to have these structures and supports in place, so all students' experiences are valued and promoted, and not disregarded or devalued. This may mean alternative texts, different response formats, or integration of assistive technology. Teachers in the classroom, when they have the right mindset, have this fundamental role of knowing all the available tools to engage learning of all students.

TEACHER TRAINING

A central and last piece to be discussed in this chapter is training. If we expect teachers and administrators to put in place the structures, supports and strategies necessary to successfully include a diverse population of students, they need to be equipped with those tools. Therefore, we need to consider the role of experience, pre-service and in-service teacher education and development, especially for teaching students with disabilities. In Brazil, teachers will generally be assigned to inclusive

classrooms having only a few credits in special education, and without having prior experience teaching during college preparation, practicum hours and even less time interacting with students with a disability label (FEUSP, 2016). On the other hand, in the United States, all students complete four year undergraduate degrees, with direct teaching experience. In New York State, for example, the requirement was recently raised to 14 weeks of student teaching with at least 100 hours of additional clinical practice prior to student teaching. Further, all teachers must earn a master's degree to earn professional certification. There are additional exams that must be passed in order to be eligible to teach. Coursework and clinical experiences must address a content core and a pedagogical core. All teachers, regardless of certification area must earn at least three credit hours in supporting students with disabilities. Those seeking certification in the area of students with disabilities must complete a program specifically targeted at that population, including specific coursework on topics including understanding the needs of students with disabilities, assessment, classroom management, instructional planning and working with families and caregivers. We highlight these staggering differences not to downplay the quality of Brazilian teachers, but to show the unfairness of placing Brazilian teachers in fully inclusive classrooms without the hours of training or practicum for such. These numbers are useful to examine the need to invest in teachers, who are our front liners in promoting inclusive education.

All in all, this chapter aimed in providing an overview of what should be minimally in place so that we can call inclusive the practices and

education provided. Inclusive education is a process that needs to be worked on in every school, because it is always in progress and it will depend individually on students, teachers, schools and geographical location. We hope to motivate you to look for more practices to complement the current state of inclusion in your school and provide more and more resources for all involved in this rewarding process.

REFERENCES

- Ashby, C., Woodfield, C. & Delia, Q. (2016). Communication is the root of necessity: Constructing communicative competence. In C. Ashby & M. Cosier (Eds.), *Enacting change from within: Disability studies meets teaching and teacher education*. New York, NY: Peter Lang.
- Ashby, C. & Woodfield, C. (2019). Honouring, constructing and supporting neurodivergent communicators in inclusive classrooms. *International Perspectives on Inclusive Education*, 13, 151-167.
- Biklen, D., & Burke, J. (2009). Presuming competence. *Equity & Excellence in Education*, 39(2), 166-175. doi:10.1080/10665680500540376.
- BRASIL. (2008). Ministério da Educação. Secretaria de Educação Especial (SEESP). *Política Nacional de Educação Especial na Perspectiva da Educação Inclusiva (National Policy on Special Education from the Perspective of Inclusive Education)*. Brasília: MEC/SEESP.
- CAST (2018). *Universal Design for Learning Guidelines version 2.2*. Retrieved from: <http://udlguidelines.cast.org>
- Carter, E.; Sisco, L. G.; Melekoglu, M. A. & Kurkowski, C. (2007). Peer Supports as an Alternative to Individually Assigned Paraprofessionals in Inclusive High School Classrooms. *Research and Practice for Persons with Severe Disabilities*, 32 (4), 213-227.
- Causton, J. & Tracy-Bronson, C. P. (2015). *The Educator's Handbook for Inclusive School Practices*. Brookes Publishing: Baltimore, MD.

Causton-Theoharis, J.; Theoharis, G.; Orsati, F. & Cosier, M. (2011). Does Self-Contained Special Education Deliver on Its Promises? A Critical Inquiry into Research and Practice. *Journal of Special Education Leadership*, 24(2), 61-78.

Cosier, M., Causton-Theoharis, J. & Theoharis, G. (2013). Does Access Matter? Time in General Education and Achievement for Students With Disabilities. *Remedial and Special Education*, 34(6), 323–332. 10.1177/0741932513485448

Dessemontet, S. R., Bless, G., & Morin, D. (2012). Effects of inclusion on the academic achievement and adaptive behaviour of children with intellectual disabilities. *J Intellect Disabil Research*, 56(6), 579-87. 10.1111/j.1365-2788.2011.01497.x.

Dessemontet, S. R, Bless, G. J. (2013). The impact of including children with intellectual disability in general education classrooms on the academic achievement of their low-, average-, and high-achieving peers. *Intellect Dev Disabilities*, 38(1), 23-30. 10.3109/13668250.2012.757589

FE USP (2016). Manual 2016 Curso de Pedagogia Faculdade de Educação da USP (Manual 2016 Pedagogy Course Faculty of Education at USP). Retrieved from: www4.fe.usp.br/wp-content/uploads/manualcursopedagogia2016.pdf

Friend, M., & Bursuck, W. (2009). Including students with special needs: A practical guide for classroom teachers. Upper Saddle River, NJ: Pearson.

Greene, R. W. (2008). Lost at school: Why our kids with behavioral challenges are falling through the cracks and how we can help them. Scribner: New York, NY.

Hehir, T. (2005). New directions in special education: eliminating ableism in policy and practice. Cambridge, MA: Harvard Education Press.

IBGE (2010). Conheça o Brasil – População PESSOAS COM DEFICIÊNCIA (Meet Brazil - Population PEOPLE WITH DISABILITIES). Retrieved from: <https://educa.ibge.gov.br/jovens/conheca-o-brasil/populacao/20551-pessoas-com-deficiencia.html>

Jorgensen, C. M., McSheehan, M., & Sonnenmeir, R.M. (2007). Presumed competence reflected in the educational programs of students with IDD before and after the Beyond Access professional development intervention. *Journal of Intellectual & Developmental Disability*, 32(4), 248–262.

Miles, S. B., & Stipek, D. (2006). Contemporaneous and longitudinal associations between social behavior and literacy achievement in a sample of low income elementary school children. *Child Development*, 77, 103-117

OECD (2019a), *TALIS 2018 Results (Volume I): Teachers and School Leaders as Lifelong Learners*, TALIS OECD Publishing: Paris. <https://doi.org/10.1787/1d0bc92a-en>.

OECD (2019b), Education GPS: The world of education at your fingertips. Retrieved from: <https://gpseducation.oecd.org/reviewededucationpolicies#!/node=41720&filter=all>

Orsati, F.T., & Causton-Theoharis, J. (2013). Challenging Control: inclusive teachers' and teaching assistants' discourses on students with challenging behavior. *International Journal of Inclusive Education*. Retrieved from: <http://www.tandfonline.com.libezproxy2.syr.edu/doi/abs/10.1080/13603116.2012.689016>

Orsati, F.T. (2016). Humanistic practices to understand and support students' behaviors: A disability studies in education framework. In Cosier, M. & Ashby, C. *Enacting change from within: Disability studies meets teaching and teacher education*. Peter Lang: New York, NY.

Mitchell, D. (2014). What really works in education: Using evidence-based teaching strategies. New York, NY: Routledge.

Scanlan, M., Theoharis, G. (2015). Introduction: Intersectionality in educational leadership. In Theoharis, G., Scanlan, M. (Eds.), *Inclusive leadership for increasingly diverse schools*. New York, NY: Routledge.

Schiavoni, A. & Martinelli, S. C. (2005). Percepção de alunos sobre as expectativas do professor acerca do seu desempenho: um estudo comparativo entre alunos com e sem dificuldades de aprendizagem (Students perception of the teacher's expectations about their performance: a comparative study between students with and without learning difficulties). *Interação em Psicologia*, 9(2), 311-319.

U.S. Department of Education (1997). Individuals with Disability Education Act Amendments of 1997 [IDEA]. (1997). Retrieved from: <https://www.congress.gov/105/plaws/publ17/PLAW-105publ17.pdf>

White, K.M. (2013). Associations between teacher-child relationships and children's writing in kindergarten and first grade. *Early Childhood Research Quarterly*, 28, 166-176.

CHAPTER 10

Students with special educational needs: role of health in the interface with education

Marina Monzani da Rocha

Decio Brunoni

Paula Racca Segamarchi

Ana Paula do Santos

José Salomão Schwartzman

INTRODUCTION

It is known that in order to achieve the diagnosis of a neurodevelopmental disorder, families tend to go through a difficult path that goes from strangeness and the first suspicions about the child's behavior, passing through the decision to seek specialized assistance. In fact, it is a stage that requires patience and attitude, as it can last a long time and implies the search for accurate information to better understand the characteristics of the child. Feelings of hope and disappointment fluctuate during this period, so the sooner these parents receive a diagnosis about their child, sooner the necessary steps will be taken to face the situation and seek appropriate treatment (Gray, 2002).

Several aspects can interfere in the path traced by the families for finding a medical explanation about the child's atypical development. Even though several signs of impaired development can be seen in very

young children, there is a widespread behavior of not valuing these complaints, because development milestones are not homogeneous. The diagnosis often happens only when the child starts school and the differences in development, in comparison with its peers, are more evident.

The trajectory of parents, and especially mothers, for the acquisition of medical information about the real clinical condition of their child, commonly goes through stages ranging from the family dealing with their own expectations, going through the urgency in obtaining information about what medical specialty to look for, until the eventual difficulty of finding a health professional who is in fact prepared to guide this family correctly. After a pilgrimage by several health professionals and services, causing a likely emotional exhaustion, parents must finally face the reality of the final diagnosis and the various interdisciplinary treatments necessary to favor the child's development.

In this context, this chapter proposes to discuss the role of health in identifying students with special educational needs and what should be observed in environmental, social and behavioral terms in children at school to assist in the process of diagnosing neurodevelopment disorders. It is understood that services structured in interdisciplinary teams offered to the population can minimize the problem of late diagnosis. Thus, we will address medical aspects, emotional/behavioral aspects, and will briefly present the results obtained in an assessment work on neurodevelopment disorders carried out by a multidisciplinary team in schools in the city of Embu das Artes/SP, Brazil.

MEDICAL ASPECTS

The intimate relationship between education and health should be emphasized, since these domains are often considered to be entirely independent without taking into account the necessary participation of Health when discussing issues related to Education. Even taking into account that there are numerous factors related to Health that must be considered in view of the need to establish causes and conduct in cases in which students are unable to contemplate the tasks proposed in class, in this space we will emphasize the cases in which varying degrees of Intellectual Disability (ID) may be present, while mentioning other neurodevelopmental disorders.

People with more evident degrees of ID are perceived more frequently, since their functional limitations are obvious. The biggest problem when we discuss this aspect in relation to school is that about 85% of the cases diagnosed with ID are categorized as mild and this population, in general, is invisible in the school environment.

The various conditions that belong to this group constitute an important health problem and are configured as being of great importance in several aspects, namely: (1) early identification; (2) accurate diagnosis; (3) adequate assessment; (4) identification of the etiology; (5) offering the necessary interventions; (6) adequacy of resources; and (7) establishing the prognosis (Shevell, 2008). They are, therefore, chronic conditions that share qualitative, quantitative deficits or both in the development of one or more of the following domains: motor skills, speech and language, cognition, personal-social domain and activities of daily living.

The best way to define ID is through a multidimensional view, according to which this condition would be characterized by a disability derived from a significant limitation in intellectual functioning and adaptive behavior expressed in conceptual, social and practical skills (American Association on Mental Retardation [AMMR], 2006). Although the difficulties result from cognitive impairments, it is evident that they are strongly influenced by environmental factors such as early diagnosis, prejudice, quality of support services, family inclusion, etc.

Estimates about the prevalence of ID vary according to the inclusion criteria and the methodologies used. According to the World Health Organization (WHO), 10% of people in the Third World, in peacetime, have some type of disability. In Brazil, the Institute of Geography and Statistics (IBGE) estimated, in 2000, the existence of 24.5 million Brazilians with disabilities (Silva, Panhoca, & Blanchman, 2004), and it is estimated that 50% of them have some degree of ID.

Possibly, due to a much higher number of people with discrete levels of ID, many disagree with the prevalence data that have been published. Most of the people in this group are not identified due to the subtlety of the signs and symptoms presented. Added to this is a trend that has strengthened that routine intelligence tests are not applied in psychological studies, which contributes to an underestimation of this population. Thus, it should be considered that possibly many of the students we find in schools with learning difficulties have undiagnosed ID, which, when mild, it can be confused with other neurodevelopmental disorders, such as attention deficit hyperactivity disorder or one of the specific learning disorders.

As for cases of mild ID, it is known that the possibility of identifying an etiology is quite remote, becoming greater in the most severe cases. According to Shevell (2008), in about three quarters of the cases in which we reach the etiology, we will find one of the following risk factors (in decreasing order of frequency): genetic syndromes or chromosomal abnormalities, intrapartum asphyxia, cerebral dysgenesis, severe psychosocial deprivation and prenatal exposure to toxic agents (for example, alcohol or other drugs). About 10% of children with global developmental delay or with ID have some cytogenetic abnormality, and in 40% of these there are no evident dysmorphic changes.

Risk factors for ID can be pre, peri or post-natal and can be classified according to biomedical, social, behavioral or educational aspects (AMMR, 2006), as listed in Table 1. In addition to these risk factors, perinatal HIV infection should always be remembered for a few decades, as children and adolescents exposed and infected with HIV-1 in the perinatal period may show signs and symptoms of more than one of the following problems: encephalopathy, intellectual disability, language delay, pyramidal signs, microcephaly, behavioral and mood disorders (Rocha et al., 2005). Thus, it is important that serological investigation for HIV-1 infection is part of the laboratory investigation protocol in cases of ID without determined etiology.

Table 1. Pre, peri and postnatal risk factors according to biomedical, social, behavioral or educational aspects, according to the AMMR (2006).

Period	Aspects			
	Biomedical	Social	Behavioral	Educational
Pre-natal	1. chromosomal disorders	1. poverty	1. parent drug use	1. losses parents' cognitive abilities (without support)
	2. disorders caused by mutations in a gene	2. maternal malnutrition	2. alcohol use by parents	3. lack of preparation for the parental role
	3. syndromes	3. domestic violence	3. parents' smoking habit	
	4. metabolic disorders	4. lack of adequate prenatal care	4. parental immaturity	
	5. cerebral dysgenesis			
	6. parental age (early or advanced)			

Perinatal	1. prematurity	1. lack of access to childbirth care	1. parental rejection	1. lack of referral for intervention after discharge
	2. childbirth insult		2. parental abandonment	
	3. neonatal disorders			
Post-natal	1. traumatic brain injury	1. compromised child-caregiver relationship	1. abuse and negligence	1. inadequate paternity
	2. malnutrition	2. lack of proper stimulation	2. domestic violence	2. late diagnosis
	3. meningoencephalitis	3. Family poverty	3. lack of safety measures	3. services of inadequate early intervention
	4. convulsive disorders	4. chronic illness in the family	4. social deprivation	4. inadequate special education services
	5. regenerative disorders	5. institutionalization	5. difficult child behaviors	5. inadequate family support

Treatments to be proposed for people with ID should be planned on a case-by-case basis, since each individual has unique peculiarities. In this planning, the degree of cognitive impairment, the degree of impairment in the various adaptive areas, other characteristics present, possible comorbidities, characteristics of families, community resources, etc., should be considered.

The fact is that we must identify the deficiency as early as possible, in order to try to minimize its effects. The treatment of conditions with ID is, in general, expensive, prolonged and with results that are usually not significant. The person will have to be diagnosed and treated by a multidisciplinary team and, in some cases, have differentiated school attendance.

In order to significantly reduce the number and severity of disability, the best approach is to prevent its occurrence. The preventive approach is the cheapest, most effective intervention and with much more interesting results not only from the point of view of the individual, but also with regard to the public health problems involved. This involves good care for pregnant women, with vaccination, identification of syphilis, detection of maternal-fetal Rh incompatibility, prevention of maternal HIV infection, among others.

Educating women to avoid using toxic substances, as is the case with some medications, as well as the dissemination of the harmful effects of the mother's use of alcohol and other drugs on the child, key to contributing to reducing the number of babies affected. In addition, public awareness campaigns to raise awareness of the risk that older women

are more likely to give birth to children with chromosomal problems, such as Down syndrome, which affects one in 600 live birth babies, could help decrease the incidence of this condition.

The obstetric problems that afflicted children frequently have decreased in a very important way, making the major birth injuries, which have been common for a few decades, become increasingly rare. The presence of the neonatologist in the delivery room has offered newborns the possibility of urgent and more efficient care in the event of hypoxemia, often avoiding neurological sequelae.

Performing the enlarged heel test early identifies the presence of phenylketonuria, congenital hypothyroidism and several other conditions that can occur with ID. The first two, if identified early and if properly treated, will not harm the development of affected children.

In view of the points discussed, it is clear that all efforts must converge to the adoption of measures that can lead to the prevention of the described conditions, since prevention, in these cases, is essential. It is important to draw attention to the relevance of correct identification of ID cases as early as possible, so that we have the possibility to offer appropriate genetic counseling to parents and to develop the most appropriate treatment plan.

In our primary care structure, it is up to the children's doctor to identify, as soon as possible, children with suspected developmental delays, so that referral to the specialist can be made without delay. However, what is usually observed is that pediatricians often do not adequately identify these cases, which was described in the work of Tanaka et al.

(2009) in a Basic Health Unit (UBS – in Portuguese, Unidade Básica de Saúde).

Another relevant topic to be discussed is the importance of health professionals addressing adverse childhood experiences (ACEs) in their practices, discussing the impact of these experiences on brain development and general health of children and adolescents, defending trauma prevention and improving services for those who have (or are) experiencing adverse experiences, a topic whose relevance will be discussed further below. Among the ACEs are: physical, sexual and emotional abuse; physical and emotional neglect; mental disorders or alcohol and drug addiction in any family member; divorce or abandonment by a parent and repeated violence against the mother, experiences that can reflect both insecurity, distrust, low self-esteem and suicidal thoughts (internalizing problems), as well as shouting, crying, presence of nightmares, challenging and self-destructive behaviors (externalizing problems).

As we have already mentioned, the treatment, as well as the diagnosis and assessment of conditions that are undergoing ID, should be multidisciplinary whenever possible, since these people present losses in several adaptive areas. The evaluation profile can help to outline the therapeutic plan and should be determined on a case-by-case basis.

Professionals from various sectors should participate in the treatment, depending on the degree and quality of the impairment, the patient's age and the goals that are being placed as the most appropriate. The participation of physiotherapists, occupational therapists, speech therapists, psychiatrists, orthopedists, psychologists, pedagogues, pedi-

atricians, neurologists and psychiatrists should be requested whenever necessary. The work of a social worker can also be just as useful.

EMOTIONAL / BEHAVIORAL ASPECTS

Considering behavioral problems such as deficits and/or behavioral excesses that cause impairment to the life of the child and of those around him, it is necessary to pay attention to the problems presented by children with school complaints, including understanding if they are causes or consequences of learning difficulties or if they are associated with ID.

Emotional/behavioral problems can be classified as Internalizing and Externalizing (Achenbach et al., 2016). Internalizing problems are those expressed in a more private way, that is, as for the individual, how they deal with difficulties and environmental stressors individually, presenting issues that are called, for example, anxiety and depression. Externalizing problems are social expressions of the difficulties experienced by the individual and include, for example, aggressiveness, disobedience and opposition. Both are associated with poor school performance (D'Abreu & Marturano, 2010). Such association indicates, in some cases, the influence of environmental variables, such as adverse conditions in the family, which further compromises the prognosis. However, it should be noted that these may or may not be direct causes of school difficulties, that is, the influence of the environment on poor school performance may exist, however, we must consider them together with individual and/or neurodevelopmental factors of the child, which highlights the importance of the health/education interface.

Regarding the family and social environment, it is known that exposure to ACEs is associated with an increased risk of behavioral and learning problems (Burke et al., 2011). As for individual and neurodevelopmental factors, there are neurodevelopmental disorders, such as Autism Spectrum Disorder (ASD), ID and specific learning disorder, which is accompanied by persistent difficulties in learning and using academic skills, resulting in performance substantially lower than expected for the child's chronological age, which generates losses in school performance and other daily activities (APA, 2014). The prevalence of this disorder is high in children of parents with reading difficulties, indicating the existence of interaction between genes and environment in determining literacy outcomes. When it comes to the environment, the one with a lack of stimulus to learning has a significant variation in the reading outcomes of children at family risk of specific learning disorder with impaired reading - Dyslexia. By associating the lack of stimuli to the experience of adverse experiences, the risk of social problems, behavior and psychiatric disorders is increased, highlighting the situation of psychosocial risk in which these children may find themselves.

Certain factors increase the risk of abuse and neglect, such as, for example, ID or any other disorder / disability that decrease the child's autonomy. However, the way parents deal with rules, behavior and affection towards their children can influence the course of emotional development, psychosocial and behavioral behavior of the child, since the plasticity of the development of the neural structure is particularly vulnerable to environmental factors.

Despite a strong reciprocal association between some neurodevelopmental disorders and psychiatric disorders, their co-occurrence is often under-recognized and undertreated (Hendren et al., 2018). An interdisciplinary and integrated approach between mental health professionals and educators can lead to comprehensive and targeted treatments that encompass both academic and mental health interventions, contributing to the improvement of educational and health-related outcomes in vulnerable children and youth. It should be noted that exposure to ACEs without adequate support leads to prolonged activation of the body's stress response systems, causing long-term changes in cortisol reactivity and immune function, affecting the development of brain structures essential for learning and memory (Burke et al., 2020).

In addition to health professionals, the school plays an important role in tracking students' behavior problems. Considering that this is the environment in which the child spends much of his/her time, it becomes a valuable resource for screening emotional and behavioral problems and an indication for early assessments and interventions that can mitigate the severity of symptoms and decrease the likelihood of negative epilogues. The integration of health and education professionals can make the diagnosis happen faster, as already discussed, and that the prognosis of the child's development is better.

A simple question, suggested by Eklund & Dowdy (2014), that can and is often used by teachers is "what happened / is happening to you?". However, as emotional and behavioral problems are often underestimated, especially internalizing problems that, due to their nature, tend to be

more difficult to observe, the use of systematic screening is proposed. It should be carried out by interdisciplinary teams, with standardized tools, proven to be more sensitive than other methods and with the potential to identify most children with significant emotional/behavioral problems, as well as neurodevelopmental disorders.

IDENTIFYING STUDENTS WITH DEVELOPMENTAL DISORDERS IN THE PUBLIC-SCHOOL SYSTEM

In Brazil, public health services are the responsibility of the Unified Health System (SUS). The SUS is organized regionally through a decentralized but connected network of health services and related activities, made up of a complex number of facilities, both public and private, to provide care. As part of the SUS, the Psychosocial Care Network (in Portuguese RAP) works in conjunction with other health networks and programs, such as the Family Health Program (PSF, the Portuguese acronym) and the Care Network for People with Disabilities (RCPD, the Portuguese acronym). In addition, there is a connection with educational and social systems. The Child and Youth Psychosocial Care Centers (CAPSis) are part of the RAP, places directly involved with diagnostic evaluation and intervention.

Designed in this way, the system should work properly, but the practice does not include the system theorist, starting with the guidelines produced by the Ministry of Health. Regarding ASD, for example, there are sometimes conflicting guidelines.

Rios and Andrada (2015) indicate the philosophical conception of conflict in the understanding of the individual with autism. It results in

heterogeneous positions with regard to diagnosis and intervention. The documentation is greater in relation to ASD, but it is known that the situation is not better in relation to ID or Attention Deficit Hyperactivity Disorder (ADHD). The prevalence of the three disorders makes them more frequent in the school population. ASD and ID, even underdiagnosed, are among the most frequent enrollments of students with special educational needs. ADHD is practically not included in these records (Teixeira et al., 2017).

With this situation, the need to produce research in this area is evident, mainly in university and public services, so that it is possible to understand exactly how people with special educational needs and their families are being accommodated, evaluated and cared for in these places. From this point of view, Brazilian production is restricted. The work points out the need to promote clinical training, including training in diagnostic instruments and early diagnosis. Considering the existing services, there is a need to expand the knowledge of best practices in this area, increase the capacity of these services and establish training programs for pediatricians and family doctors (Ribeiro et al., 2017). From the CAPSis point of view, the work of Ceballos et al. (2019), profiles them from 2008 to 2012 in a total of 837,068 records, in all Brazilian regions. It is noted that ASD represents the second frequency diagnosis in the system (12.4%).

In the Municipality of Embu das Artes, the Graduate Program in Developmental Disorders at Mackenzie Presbyterian University has been developing research and training actions in the municipal public-school

system. One of these initiatives is described in detail in another chapter of this book (Decision-making model for identifying neurodevelopmental disorders in basic education), whose method has already been published (Teixeira et al., 2020).

Another experience in the same municipality refers to the clinical characterization of students diagnosed with ASD provided by the Special Education sector of the Municipal Secretary of Education. There was no prior information on these students' clinical details beyond diagnosis. In the schools themselves, students enrolled with this diagnosis were examined and an interview with parents was conducted. The procedures were performed by two professionals with experience in the natural history of ASD: a doctor and a psychologist. A summary of this investigation is presented below.

In the period from October 2017 to August 2019, 115 students were assessed, out of a total of 140, diagnosed with ASD, enrolled in the municipal education network of city of Embu das Artes, in the great São Paulo. Through basic clinical instruments, parents or guardians were interviewed at their children's schools.

It was found that the percentage of identification and age is appropriate for the diagnosis of students with ASD; in almost all cases the diagnosis is made by the municipal public health system; the clinical profile of students with ASD showed that more than half of them are significantly compromised and need a lot of support in activities of daily living, at school and in society; ID and language impairment are presented by more than half of the sample; high number of perinatal complications,

notably events possibly harmful to the Central Nervous System and global development; comorbidities in the form of genetic syndromes and other conditions, such as epilepsy, were recorded in 21.7% of students with ASD.

FINAL CONSIDERATIONS

In this discussion about the role of health in the interface with education, we seek to discuss the conditions that attend courses with varying levels of ID, including a synthetic description of the conceptualization, classification and the most common risk factors for this underdiagnosed condition, which is often, the etiology of school difficulties presented by the child. Once again, we call attention to the crucial importance of early diagnosis, followed by investigation to identify the etiology of the condition and immediate referral for enabling treatment. It does not seem exaggerated to insist on the importance of tests of intelligence and assessment of the emotional/behavioral profile in the face of any child who presents a significant delay in development and who can manifest itself more clearly at school.

The importance of observing the context in which the student with special educational needs is inserted was also part of our discussion, with emphasis on the ACEs to which the child may have been or may be exposed, which directly impacts his brain development and health, implying learning difficulties and emotional/behavioral problems, and compromising the prognosis of the case. In this sense, we advocate that such variables need to be observed and considered in the interdisciplin-

ary planning of the intervention to lead to a better prognosis. Systematic screening should be performed by interdisciplinary teams to screen students with significant emotional/behavioral problems, as well as neuro-developmental disorders.

This work should be carried out in school systems in the early stages of elementary school, in order to identify students with special educational needs. For this, teachers in general, and special education sectors in particular, must have access to consultants with theoretical knowledge about the main developmental disorders as well as master assessment instruments specially developed for teachers. Interlocution with the municipality's health system is fundamental for the validation of diagnoses and clinical characterization of these students from the cognitive, behavioral, and functional point of view.

REFERENCES

- Achenbach, T. M., Ivanova, M. Y., Rescorla, L. A., Turner, L. V., & Althoff, R. R. (2016). Internalizing/Externalizing problems: Review and recommendations for clinical and research applications. *Journal of the America Academy of Child and Adolescent Psychiatry*, 55(8), 647-656. doi: 10.1016/j.jaac.2016.05.012
- American Association on Mental Retardation – AMMR. (2006). Retardo mental: definição, classificação e sistemas de apoio (Mental retardation: definition, classification and support systems). [Tradução de Magda França Lopes]. 10. Ed. Porto Alegre: Artmed.
- American Psychiatric Association – APA. (2014). Manual diagnóstico e estatístico de transtornos mentais. – DSM-5. Porto Alegre: Artmed.
- Burke, N. J., Hellman, J. L., Scott, B. G., Weems, C. F., Carrion, V. G. (2011). The Impact of adverse childhood experiences on na urban pediatric population. *Child Abuse Negl.*, 35 (6), 408-13.

- Ceballos, G. Y., Paula, C. S., Ribeiro, E. L., & Santos, D. N. (2019). Child and Adolescent Psychosocial Care Center service use profile in Brazil: 2008 to 2012. *Braz. J. Psychiatry*, 41(2), 138-147. Doi: <http://dx.doi.org/10.1590/1516-4446-2018-0011>.
- D'Abreu, L. C. F., Marturano, E. M. (2011) Identificação de problemas de saúde mental associados à queixa escolar segundo o DAWBA. *PSICO*, 42 (2), 152 – 158.
- Eklund, K., Dowdy, E. (2014). Screening for behavioral and emotional risk versus traditional school identification methods. *School Mental Health*. 6, 40-49.
- Gray, D. (2002). Ten years on: a longitudinal study of families of children with autism. *Journal of Intellectual & Developmental Disability*, 27(3), 215-222.
- Hendren, R. L., Haft, S. L., Black, J. M., Hoeft, F. (2018). Recognizing psychiatric comorbidity with reading disorders. *Frontiers in Psychiatry*. 9.
- Shevell, M. (2008). Global developmental delay and mental retardation or intellectual disability: conceptualization, evaluation, and etiology. *Pediatr Clin North Am*; 55:1071-84.
- Silva, O. M. P., Panhoca, L., & Blanchman, I. T. (2004). Os pacientes portadores de necessidades especiais: revisando os conceitos de incapacidade, deficiência e desvantagem (Patients with special needs: reviewing the concepts of disability, handicap and disadvantage). *Salusvita*, 23(1):109-16.
- Ribeiro, S. H., Paula, C. S., Bordini, D., Mari, J. J., & Caetano, S. C. (2017). Barriers to early identification of autism in Brazil. *Rev Bras Psiquiatr.*, 39, 352-354.
- Rios, C., & Andrade, B. C. (2015). The changing face of autism in Brazil. *Cult. Med. Psychiatry*, 39, 213-234.
- Rocha, C., Gouvêa, A., Machado, D., Cunegundes, L., Beltrão, S., Bononi, F., & Succi, R. C. (2005). Manifestações neurológicas em crianças e adolescentes infectados e expostos ao HIV-1 (Neurological manifestations in children and adolescents infected and exposed to HIV-1). *Arq Neuropsiquiatr*, 63(3B), 828-31.
- Tanaka, O. U., & Ribeiro, E. L. (2009). Ações de saúde mental na atenção básica: caminho para ampliação da integralidade da atenção (Mental health actions in primary care: way to expand comprehensive care). *Cienc Saúde Coletiva*, 14(2), 77-86.
- Teixeira, M. C. T. V., Brunoni, D., Carreiro, L. R. R., Braga, A. C., & Paula, C. S. (2017). Mismatch between diagnostic reports and special educational needs classification in a public educational system *Arq. Neuro-Psiquiatr.*, 75(4).

Teixeira, M. C. T. V., Carreiro, L. R. R., Seabra, A. G., Silva, L. A., Rossi, A. C., Tafla, T. L., Lopes, E. F. D., & Brunoni, D. (2020). Decision-making model for elementary school teachers to identify autism and intellectual disability ETD- Educação Temática Digital, 22(1), 106-126.

CHAPTER 11

Autism in Brazil: from the early diagnostic related factors to the guarantee of rights

Vanessa Madaschi

Rosane Lowenthal

Tatiana Sasaki

Daniela Bordini

Gracielle Rodrigues da Cunha

Cristiane Silvestre de Paula

Autistic Spectrum Disorder (ASD) is a neurodevelopmental disorder beginning in early childhood; with chronic course, it remains during adolescence and adulthood, and is associated with a great emotional and economic burden (Paula *et al.*, 2017).

In the light of science, it is of great relevance to investigate what are the barriers in order to reach the diagnosis as early as possible, anchored in the robust theoretical framework of the importance of interdisciplinary intervention in the early stages of child development. The next step is to share this knowledge with society, outlining public policies that allow the guarantee of rights, helping to expand and guarantee access to services based on a broader understanding of the concept of inclusion, and also based on the theoretical model of law, in which the person should be included in the natural contexts of life, offering citi-

zenship conditions so that he can exercise social roles according to his age, whether at school, at work or in independent life. The goals are for functionality and participation.

American estimates point to an increase in the diagnosis of ASD, with a prevalence of 1 to 166 children in 2004, increasing to 1 in 59 children in 2018 (Baio et al., 2018). Dozens of studies of this nature have already been carried out, mainly in developed countries, indicating the best estimate of an ASD rate between 0.6 to 1.0% of the population (Baio et al., 2018; Fombonne et al., 2018; Baxter et al., 2015).

Its causes are not fully known, but certainly a neurobiological basis of multifactorial origin, with a strong genetic component combined with the individual's exposure to environmental events, particularly in the pre and perinatal periods (Chaste & Leboyer 2012; Kim & Leventhal, 2015). A twin meta-analysis study estimated heredity in the range of 64% to 91%, while estimates of the environment's contribution to the development of ASD vary according to surveys from 1% to 35% (Bai et al., 2019; Yip et al., 2018).

EARLY DIAGNOSIS

Alongside the issues related to the etiology of the disorder, researchers focus on aspects related to the diagnosis of ASD (Bai et al., 2019; Tick et al., 2016). Recent follow-up studies of children at risk for ASD (children who had an older sibling with ASD, for example) show that clinical signs emerge at the end of the first year of life and become stable until the end of the second year, when a more reliable diagnosis can

be made (Landa, Gross, Stuart & Faherty, 2013; Zwaigenbaum, Bryson, Rogers, Roberts, Brian, & Szatmari, 2005; Bai et al., 2019). It is currently considered that in approximately 80% of cases, ASD is detectable until the age of 24 months (BAI et al., 2019). There is evidence that parents can identify concerns in the development of their children with ASD before 12 months of age (Bolton et al., 2012; Kozlowski et al., 2011) and the recommendation that the characteristics of ASD should be identified before the child turns three.

Strong evidence points to the importance of early intervention in children suspected of ASD (Landa, 2018; Su Maw & Haga, 2018; McMahon & Griffith 2017; Zwaigenbaum & Penner, 2018). The first step in ensuring care and access to specific programs is through a diagnosis, by screening, identification, and adequate referrals. A number of international guidelines provide parameters not only for screening, but also comprehensive high-quality assessments at a very early stage in the development of babies. However, these more complete models require many resources and high specialization of the professionals involved, which can result in excessive waiting time, which often does not correspond with the availability of services, whether human resources or instruments for a specific ASD diagnostic evaluation (Zwaigenbaum & Penner, 2018). In accordance to that, studies on early identification seek to evaluate different strategies applied.

Daniels and Mandell (2014), in a review study, identified 35 different approaches which were grouped into the following categories: awareness, routine screening and improvement of professional practic-

es aimed at improving screening. Most of the studies that implemented routine screening almost always performed in childcare consultations, pointed to a greater recognition in suspected cases. However, there are several challenges common to the implementation of routine screening. The main barriers include the effect of changing the practice in the context of limited time and resources, identification of the ideal manner and context of screening, lack of follow-up of cases with positive screening, and lack of professional knowledge about screening tools.

A literature review (Daniels et al., 2014), assessed barriers related to delayed diagnosis, which will be described below. This data also points out that there has been a trend in recent years towards an earlier diagnosis. However, recent studies show that there are disparities that may be related to the characteristics of the child, family and community.

The barriers related to the late age of diagnosis were: (i) lesser severity of symptoms (that is, milder cases are detected later); (ii) low family socioeconomic status; (iii) delay in the parents' concern with the initial symptoms; (iv) place of residence of the family (rural area); (v) lack / limitation of community resources and organization of public policies and (vi) relationship problems or lack of trust / access of family members to health and education systems. Such factors point in the direction of the knowledge that factors other than the clinical presentation may be related to the age of diagnosis (Daniels & Mandell, 2014).

In general, the literature points out that the early identification of cases is strongly linked to the early recognition of developmental problems by parents and / or main caregivers as well as a greater knowledge

of clinical and behavioral signs, and symptoms, by professionals in the field, development surveillance, as well as greater access to information by the general population. Initially, much like an educational process. The first clinical signs of ASD are related to a delay in the main motor milestones, language and social communication, in addition to the presence of stereotyped behaviors, unusual manipulation of objects and incongruous regulation of emotions. These signs are usually present in the first year of life, but with a low rate of detection of delayed child development. (Williams & Clinton, 2011; Einspieler, Peharz & Marschik, 2016). More severe forms of autism can be detected by families in the first year of life but are still rarely treated before 3 years of age (Viaux Savelon et al., 2018).

The empirical and review studies presented above reveal that despite advances in the field of early detection, there is a great variation in relation to the average age of diagnosis of ASD, which remains on average between 3.5 and 5 years of age (Zwaigenbaum & Penner, 2018) and many challenges in the early identification and intervention of babies and children with ASD. These results are particularly important considering that the diagnosis of ASD is stable and reliable, in most cases, at 24 months of age (Ozonoff, Young, Landa et al., 2015). Delayed diagnosis is a missed opportunity to provide early intervention, and consequently to improve the functional prognosis of these children, increasing the opportunity for better functionality of these people in adulthood, with greater autonomy and less need for support and / or assistance from third parties (Whitehouse, 2017; Viaux Savelon et al., 2018).

When identifying the factors associated with the age of ASD diagnosis, studies propose some solutions so that this interval between the perception of the first warning signs and the diagnosis is reduced. A first suggestion involves changes in public policies effective in different countries, such as: expanding the number of centers that carry out evaluations, as well as expanding the number of professionals working in existing centers and establishing new teams to work at communities nearby those families. Another guideline would be to care for babies at risk, without waiting for the diagnosis of ASD to be established. There is evidence in the literature that demonstrates effectiveness for this intervention model (Viaux Savelon et al., 2018).

Studies also point out that early detection efforts should include parent/primary caregiver education on early recognition of developmental problems, interventions aimed at streamlining the process, from early concerns to the final diagnosis, as well as strategies aimed at underserved populations. Among several sensitive points for this statement, it is pointed out that during the first year of life the symptoms of children at risk are not specific and can be transient and not permanent. The only symptom that is permanent is the lack of desire to form relationships, that is, social interaction (Viaux Savelon et al., 2018).

Considering that children with ASD present important changes in specific developmental domains, such as communication, socialization and cognition, requiring permanent care in varying degrees throughout their lives, it is essential to identify the factors that promote a faster diagnosis or that lead to its delay, as well as, consistently evidence the

data described in the literature on diagnostic age. National studies are an important next step, as such estimates can be valuable in planning public policies aimed at this population.

GUARANTEE OF RIGHTS

Important social normative instruments of the first half of the last century referred only to the social security of people with disabilities, offering no guarantees as to their education or the possibility of working and effectively exercising their citizenship. This information is ensured both in the Universal Declaration of Human Rights (UN, 1948), and in the Brazilian Federal Constitution of 1934, 1937 and 1946, (IBGE, 2018). It was in the second half of the 20th century that the eyes of the international society turned not only to rehabilitation, but also to social guarantees for the integration of people with disabilities (IBGE, 2018).

Dated only as of 1971, the resolution 2856 (XXVI) stated the first international legislation protecting the rights of people with intellectual disabilities. This regulation advocated the rights to education, treatment, rehabilitation, family inclusion, the need for protection, the right to protection from exploitation, degrading treatments and any type of abuse (UN, 1971). In 1975, the Declaration of the Rights of Persons with Disabilities was approved, which expanded the understanding and concepts of disability, beyond intellectual, on the issues of autonomy and self-confidence (UN, 1975). It listed rights not only those related to health, social security and social assistance, but also civil, political and social rights.

In 1981, UN declared the International Year of People with Disabilities and launched the World Program of Action for People with Disabilities the following year, with specific programs and concrete goals for policy planning, implementation and monitoring. It built materials with technical recommendations for statistics and reports, mainly in developing countries, in order to compare such information internationally. Since then, the theme has received more attention from official statistical institutes on all continents, offering information of paramount importance for decision-making on specific public policies aimed at this population (IBGE, 2018).

Thus, in 2011, UN used data from the World Health Organization (WHO) to report that 1 billion people lived with some disability in the world. Of these, 80% live in developing countries. It is also noteworthy that among the poorest people in the world, 20% had some type of disability (UN, 2011). According to UNICEF (2006), of this total, 150 million children under the age of 18 have a disability. Another alarming data from this group is that these children are more likely to be victims of violence and that 90% of people living in developing countries do not attend schools.

An important landmark published in 1980 by the WHO, was the International Classification of Disabilities, Disabilities and Disadvantages - CIDID, classifying the consequences of diseases, injuries and other disorders and the implications of these consequences in people's lives. Through CIDID, three dimensions were consolidated: impairments, disabilities and handicaps. Over time, CIDID has become, in addition to a clinical tool, an instrument of social and statistical policy, guiding the

collection and registration of data on people with disabilities. In 2001, breaking through, the International Classification of Functionality, Disability and Health - CIF was approved by WHO, which started to present a new way of measuring health and disabilities, considering environmental factors and encompassing the social paradigm to the doctor, proposing a biopsychosocial approach to people with disabilities. From the publication of the CIF, WHO developed a series of tools for the operationalization of the Classification, among which the ICF Core Sets in Clinical Practice and the ICF Checklist for primarily clinical purposes. And the WHO Disability Assessment Schedule and the Model Disability Survey with the purpose of instrumentalizing population studies.

In Brazil, according to the Ministry of Health, the first investigations of disability in the population date back to the 19th century. However, it was only from the end of the 1980s that relevant actions were launched in relation to people's rights, by means of the Brazilian Constitution (1988) and Federal Law 7853, ensuring the exercise of individual and social rights and guaranteeing the obligation to include deficiency questions in the demographic censuses of 1991, 2002 of 2010. (Ministry of Health, 2019). According to the last census conducted in 2010, and data reviewed in a study entitled 'National and International Panorama of the Production of Social Indicators',– specific population groups and the use of time, by the Brazilian Institute of Geography and Statistics in 2017, Brazil had 12.5 million people with some disability, totaling about 6.7% of the population (IBGE, 2018). It is known that this data is inaccurate due to methodological limitations, but they represent a national

landmark, since that for the first time a national survey of this scope is established.

In parallel, in relation to the educational aspects aimed at this population, after the Conventions on the Rights of Children (1990) and the Salamanca Declaration on Education for All (1994), principles and policies with regards to special aid education were instituted, guaranteeing every child the right to education, and for those with special needs access to regular school, providing pedagogy centered on the individual needs' of each child.

In 2008, the “National Policy on Special Education from the perspective of Inclusive Education” was formulated with broad participation by civil society and education managers and educators from all over Brazil. This policy guarantees access, participation and learning for students with motor, sensory, intellectual, and multiple disabilities in addition to global developmental disorders and high skills / giftedness in regular schools. It also guarantees that special education is transversal, from early childhood education to higher education; specialized educational assistance (AEE); continuing schooling at the highest levels of education; the training of teachers for AEE and other education professionals for school inclusion; family and community participation; urban, architectural accessibility in furniture and equipment, transport, communication and information; and intersectoral articulation in the implementation of public policies.

Specifically addressing the guarantee of the rights of people with ASD, despite the advances achieved under previous laws, it was only in 2012, through federal law No. 12,764 (popularly known as ‘Lei Berenice Piana’) that the Brazilian government instituted the National Policy Pro-

tection of the Rights of the Person with ASD. Thus, the rights of people with ASD are enshrined, specifying the guarantees of early diagnosis, multidisciplinary care, adequate nutrition, and medications, with a view to comprehensive care to their needs.

In line with the National Education Guidelines and Bases Law (Law 9.394 / 96), this policy ensures that the person with ASD is included in regular educational classes, also bearing the right to a specialized assistant when necessary, and inclusive / aided education at all regular schooling levels, subject to a fine if the school does not comply or refuses to allow their enrollment (BRASIL, 2012). The Statute of Persons with Disabilities (2016, Art. 28, XI), is also categorical when it enshrines the right to educational training and the availability of teachers for specialized educational assistance and support professionals in the classroom in order to achieve the maximum possible development, according to their characteristics, interests and learning needs.

Moving to the most recent historical moment, in July 2015, the Brazilian Inclusion Law - LBI (Law 13.146 / 15) was sanctioned. This law, also known as the Statute for Persons with Disabilities, is intended to ensure and promote, on equal terms, the exercise of the fundamental rights and freedoms of persons with disabilities, with a view to their social inclusion and citizenship. The LBI summarizes the rights and duties of persons with disabilities, previously distributed in various laws. It is made up of 127 articles, with a series of innovations such as the right to decide, no longer allowing total interdiction, thereby not revoking disabled people's intrinsic human rights.

Historically, people with ASD, as well as people with disabilities, face discrimination and barriers that hinder access to their rights. As a result, individuals with ASD have long been marginalized and excluded from social life. Policies and legislation are important to guarantee social inclusion and the resumption of rights. Advances in health and education have been noted in Brazil, especially from 2016 and 2017, with guarantees under the law of an assessment for child development and advances in education through the principles of equity and equal rights, ensuring specific learning needs.

The understanding of the historical trajectory which involves the transition from the health model to the model of rights, alongside access to services and citizenship is fundamental because it amplifies the participation of all citizens in an active process of promoting citizenship and health. As a cascade reaction, the inclusion of people with ASD as active people involved in processes, allows society's perception of diversity to expand. Through the consolidation of these rights, the expansion of knowledge and the continuous occupation of social spaces, some gaps can be filled, such as the diagnosis and guarantees of necessary interventions at an early stage and throughout life.

Despite advances identified to date, we would like to highlight more vulnerable groups due to the lack of specific public policies. Particularly those aimed at adolescents, adults and the elderly with ASD in Brazil, many of whom are unassisted in their specific needs, and lacking in opportunities for social participation.

REFERENCES

- Araújo LA de, Loureiro AA, Alves AMG, Lopes AMC da S, Barros JCR, Chaves LF da S, et al. Triagem precoce para Autismo/ Transtorno do Espectro Autista (Early Screening for Autism / Autism Spectrum Disorder). Documento Científico. Belo Horizonte; 2017
- Araújo, R. R. de (2012). Estudo piloto para o mapeamento da trajetória em busca de diagnóstico e tratamento do Transtorno do Espectro do Autismo no município de Barueri em São Paulo (
- Pilot study to map the trajectory in search of diagnosis and treatment of Autism Spectrum Disorder in the municipality of Barueri in São Paulo). (Dissertação de Mestrado). Recuperado de <http://tede.mackenzie.br/jspui/handle/tede/1581>.
- Bai, D. et al. (2019). Association of Genetic and Environmental Factors With Autism in a 5-Country Cohort. *JAMA Psychiatry*, 76(10), 1035.
- Baxter, A. J. et al. (2015). The epidemiology and global burden of autism spectrum disorders. *Psychological Medicine*, 45(03), 601–613.
- Bolton, P. F. et al. (2012). Autism Spectrum Disorder and Autistic Traits in the Avon Longitudinal Study of Parents and Children: Precursors and Early Signs. *Journal of the American Academy of Child & Adolescent Psychiatry*, 51(3), 249- 260.e25.
- Brasil. Ministério da Saúde. Secretaria de Atenção à Saúde. Departamento de Ações Programáticas Estratégicas. Diretrizes de Atenção à Reabilitação da Pessoa com Transtornos do Espectro do Autismo (TEA) / Ministério da Saúde, Secretaria de Atenção à Saúde, Departamento de Ações Programáticas Estratégicas. – Brasília: Ministério da Saúde, 2014. Disponível em: https://bvsms.saude.gov.br/bvs/publicacoes/diretrizes_atencao_reabilitacao_pessoa_autismo.pdf Acessado em: 01/05/2020.
- Brasil. Ministério da Saúde. Secretaria de Atenção à Saúde. Departamento de Atenção Especializada e Temática. Linha de cuidado para a atenção às pessoas com transtornos do espectro do autismo e suas famílias na Rede de Atenção Psicossocial do Sistema Único de Saúde / Ministério da Saúde, Secretaria de Atenção à Saúde, Departamento de Atenção Especializada e Temática. – Brasília: Ministério da Saúde, 2015. Disponível em: http://bvsms.saude.gov.br/bvs/publicacoes/linha_cuidado_atencao_pessoas_transtorno.pdf Acessado em: 01/05/2020.

Brasil, Ministério da Saúde. (2002). Portaria 1.635/GM em 12 de Setembro de 2002. Brasília-DF,2002. Disponível em: <<https://saude.rs.gov.br/upload/arquivos/carga20171008/13130834-1421676330-portaria-n-1635-de-12-de-setembro-2002-novos-procedimentos.pdf>> Acessado em: 11/11/2019.

Brasil, Ministério da Saúde. (2013). Rede de cuidados à pessoa com deficiência (Care network for people with disabilities). Brasília-DF, 2013. Disponível em: <http://bvsms.saude.gov.br/bvs/folder/rede_cuidado_pessoa_com_deficiencia.pdf> Acessado em: 23/12/2019.

Brasil, Ministério da Saúde. (2014). Secretaria de Atenção à saúde. Departamento de ações programáticas estratégicas. Diretrizes de atenção à reabilitação da pessoa com transtorno do espectro do autismo (TEA). Brasília: ministério da saúde, 2014. Disponível em: https://bvsms.saude.gov.br/bvs/publicacoes/diretrizes_atencao_reabilitacao_pessoa_autismo.pdf. Acessado em 23/12/2019.

Brasil, Ministério da Saúde. (2009). Decreto 6.949 de 25 de Agosto de 2009. Convenção Internacional sobre os Direitos das Pessoas com Deficiência. Disponível em: http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2009/decreto/d6949.htm>Acessado em 11/11/2019.

Brasil, Ministério da Saúde. (2001). Decreto No 3.956, de 8 de outubro de 2001. Promulga a Convenção Interamericana para a Eliminação de Todas as Formas de Discriminação contra as Pessoas Portadoras de Deficiência. Guatemala: 2001. Disponível em: <https://www2.camara.leg.br/legin/fed/decleg/2001/decretolegislativo-198-13-junho-2001-337086-convencao-1-pl.html>>Acessado em 11/11/2019.

Brasil. (2014). Decreto nº8.368 de 2 de dezembro de 2014. Regulamenta a Lei nº12.764. Brasília, DF. Disponível em:< http://www.planalto.gov.br/ccivil_03/_Ato2011-2014/2014/Decreto/D8368.htm> Acessado em: 11/11/2019.

Brasil. (1990). Estatuto da Criança e do Adolescente no Brasil (Statute of Children and Adolescents in Brazil). Lei no 8.069, de 13 de julho de 1990. Disponível em: http://www.planalto.gov.br/ccivil_03/leis/l8069.htm>Acessado em 23/12/2019.

Brasil. (2012). Lei nº 12.764 de dezembro de 2012. Política nacional de proteção dos direitos da pessoa com transtorno do espectro autista. Brasília,DF. Disponivel em: < http://www.planalto.gov.br/ccivil_03/_Ato2011-2014/2012/Lei/L12764.htm> Acessado em 11/11/2019.

Brasil. LEI nº 13.438 de 26 de Abril de 2017, que altera a Lei nº 8.069, de 13 de julho de 1990(Estatuto da Criança e do Adolescente). Brasília,DF. Disponivel em:< http://www.planalto.gov.br/ccivil_03/_Ato2015-2018/2017/Lei/L13438.htm> Acessado em 11/11/2019

Brasil, Ministério da Educação. (2008). Secretaria de Educação Especial (SEESP). Política Nacional de Educação Especial na Perspectiva da Educação Inclusiva. Brasília: MEC/SEESP, 2008. Disponível em: <http://portal.mec.gov.br/arquivos/pdf/politicaeducespecial.pdf>.Acessado em 23/12/2019.

Brasil, Constituição da República Federativa do Brasil. (1988). Brasília: Senado Federal, 1988. Disponível em: <http://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm> Acessado em 23/12/2019.

Chaste, P. & Leboyer, M. (2012). Autism risk factors: genes, environment, and gene-environment interactions. *Dialogues in clinical neuroscience* 14(3), 281.

Children's Hospital Association. (2018). Pediatric Specialist Physician Shortages Affect Access to Care. [s.l: s.n.]. 2018. Disponível em: <https://www.childrenshospitals.org/~media/Files/CHA/Main/Issues_and_Advocacy/Key_Issues/Graduate_Medical_Education/Fact_Sheets/Pediatric_Specialist_Physician_Shortages_Affect_Access_to_Care08012012.pdf> Acessado em 10/01/2020.

Daniels, A. M. et al. (2014). Approaches to Enhancing the Early Detection of Autism Spectrum Disorders: A Systematic Review of the Literature. *Journal of the American Academy of Child & Adolescent Psychiatry*, 53(2) 141–152.

Daniels, A. M. & Mandell, D. S. (2014). Explaining differences in age at autism spectrum disorder diagnosis: A critical review. *Autism*, 18(5), 583–597.

DEFENSORIA PÚBLICA DO ESTADO DE SÃO PAULO. (2011). Cartilha dos direitos das pessoas com autismo. Março de 2011. São Paulo,2011. Disponivel em: <<https://www.revistaautismo.com.br/CartilhaDireitos.pdf>> Acessado em: 11/11/2019

Einspieler, C., Peharz, R. & Marschik, P. B. (2016). Fidgety movements – tiny in appearance, but huge in impact. *Jornal de Pediatria*, 92(3), S64–S70.

Fombonne, E. (2018). Editorial: The rising prevalence of autism. *The journal of child psychology and psychiatry*, 7(7), 717–720.

Kim, Y. S. & Leventhal, B. L. (2015). Genetic epidemiology and insights into interactive genetic and environmental effects in autism spectrum disorders. *Biological psychiatry*, 77(1) 66-74.

Kozlowski, A. M. et al. (2011). Parents' first concerns of their child's development in toddlers with autism spectrum disorders. *Developmental Neurorehabilitation*, 14(2) 72–78.

Landa, R. J. (2018). Efficacy of early interventions for infants and young children with, and at risk for, autism spectrum disorders. *International Review of Psychiatry*, 30(1) 25–39.

Landa, R. J., Gross, A. L., Stuart, E. A., & Faherty, A. (2013). Developmental trajectories in children with and without autism spectrum disorders: the first 3 years. *Child development*, 84(2), 429-442.

Maenner, M. J., Shaw, K. A., Baio, J. et al. (2016). Prevalence of Autism Spectrum Disorder Among Children Aged 8 Years — *Autism and Developmental Disabilities Monitoring Network*, 69(4), 1–12.

OAB/DF. Cartilha dos direitos da pessoa autista. (2018). Seccional da Ordem dos advogados do Brasil do Distrito federal. Gestão 2016/2018. Disponível em: <[https://www.prefeitura.sp.gov.br/cidade/secretarias/upload/Cartilha%20Autismo%20WEB\(1\).pdf](https://www.prefeitura.sp.gov.br/cidade/secretarias/upload/Cartilha%20Autismo%20WEB(1).pdf)> Acessado em 11/11/2019

OAB/DF. Cartilha dos direitos da pessoa com autismo. (2015). Comissão de defesa dos direitos da pessoa com autismo. Gestão 2012/2015. Disponível em: <<http://www.oabdf.org.br/cartilhas/cartilha-direitos-da-pessoa-com-autismo/>> Acessado em 23/12/2019

ONU. Declaração de Salamanca e Enquadramento da ação (Salamanca Declaration and Framework for the action). Conferência Mundial sobre Necessidades Educativas Especiais: Acesso e Qualidade, 1994. Disponível em: <http://portal.mec.gov.br/seesp/arquivos/pdf/salamanca.pdf> Acessado em 23/12/2019.

ONU. Declaration on the rights of Disable persons. Resolução 3447(XXX) da Assembleia geral das Nações Unidas, 9 de dezembro de 1975. Disponível em: <<https://www.ohchr.org/EN/ProfessionalInterest/Pages/RightsOfDisabledPersons.aspx>> Acessado em 23/12/2019.

ONU. Declaration on the rights of mentally retarded persons. (1971). Resolução 2856 (XXVI) da Assembleia Geral das Nações Unidas. 20 de dezembro de 1971. Disponível em: <<https://www.ohchr.org/EN/ProfessionalInterest/Pages/RightsOfMentallyRetardedPersons.aspx>> Acessado em 23/12/2019.

ONU. Office for Disability Issues. (2011). Disability facts and figures: An overview of official UK disability statistics from the Office for Disability Issues. Disponível em: www.odi.dwp.gov.uk/disability-statistics-and-research/disability-facts-and-figures.php#3. Acessado em accessed 21/02/2020.

Organização das Nações Unidas (2010). Greater awareness and understanding of autism needed, says UN chief. UN News Centre. Retrieved from <http://www.un.org/apps/news/story.asp?NewsID=34272#.UgQq51c5fU> Acessado em 11/12/2019.

Ozonoff, S., Young, G. S. & Landa, R. J., et al. (2015). Diagnostic stability in young children at risk for autism spectrum disorder: A Baby Siblings Research Consortium Study. *J Child Psychol Psychiatry*, 56(XX), 988-998.

Paula, C. S. et al. (2011). Brief Report: Prevalence of Pervasive Developmental Disorder in Brazil: A Pilot Study. *Journal of Autism and Developmental Disorders*, 41(12), 1738–1742.

Paula, C. S., Cunha, G. R., Coltri, L. & Teixeira, M. C. T. (2017). Conceituação do Transtorno do Espectro Autista: definição e epidemiologia (Conceptualization of Autistic Spectrum Disorder: definition and epidemiology). In: Bosa, C. A. M., & Teixeira, M. C. T. (Eds.), *Avaliação psicológica e neuropsicológica da pessoa com Transtornos do Espectro Autista*. (p. XX-295). São paulo: Hogrefe.

PRESIDÊNCIA DA REPÚBLICA. (2019). Cartilha viver sem limites: Plano nacional dos direitos da pessoa com deficiência (Primer live without limits: National plan for the rights of people with disabilities). Brasília, 2013. Disponível em: <http://www.desenvolvimentosocial.sp.gov.br/a2sitebox/arquivos/documentos/633.pdf>. Acessado em 23/12/2019.

Ribeiro SH, Paula CS de, Bordini D, Mari JJ, Caetano SC. Barriers to early identification of autism in Brazil. *Rev Bras Psiquiatr*. 2017;39(4):352–4.

Su Maw, S. & Haga, C. (2018). Effectiveness of cognitive, developmental, and behavioural interventions for Autism Spectrum Disorder in preschool-aged children: A systematic review and meta-analysis. *Heliyon*, 4(9), e00763.

Tick, B. et al. (2016). Heritability of autism spectrum disorders: a meta-analysis of twin studies. *Journal of Child Psychology and Psychiatry*, 57(5), 585–595.

UNICEF. (2019). The State of the World's Children – excluded and Invisible. Disponível em: www.unicef.org/spanish/sowc/ ^/index.php. Acessado em 21/02/2020.

- Viaux Savelon, S. et al. (2018). Dépister et prendre en charge les troubles du spectre de l'autisme en périnatalité. *Soins Psychiatrie*, 39(319), 33–39.
- Whitehouse, E. A. J. O. (2017). Elizabeth Usher Memorial Lecture: Rethinking the clinical pathway for autism spectrum disorder and challenging the status quo. *International Journal of Speech-Language Pathology*, 19(3), 208–217.
- Williams, R. & Clinton J. (2011). Canadian Paediatric Society, Early Years Task Force. Getting it right at 18 months: in support of an enhanced well-baby visit. *Paediatric Child Health*, 16(10), 647-54.
- WORLD HEALTH ORGANIZATION. (2010). International statistical classification of diseases and related health problems ICD-10. Geneva: [s.n.].
- World HEALTH ORGANIZATION. (2014). WHA resolution on “Comprehensive and Coordinated Efforts for the Management of Autism Spectrum Disorders” [Internet]. 2014 May 24 [cited 2017 Jun 26].
- Yip, B. H. K. et al. (2018). Heritable Variation, With Little or No Maternal Effect, Accounts for Recurrence Risk to Autism Spectrum Disorder in Sweden. *Biological Psychiatry*, 83(7) 589–597.
- Zwaigenbaum, L., Bryson, S., Rogers, T., Roberts, W., Brian, J., & Szatmari, P. (2005). Behavioral manifestations of autism in the first year of life. *International journal of developmental neuroscience*, 23(2-3) 143-152.
- Zwaigenbaum, L. & Penner, M. (2018). Autism spectrum disorder: advances in diagnosis and evaluation. *BMJ*, V.(N), k1674.

CHAPTER 12

The contribution of speech therapy in programs to support students with difficulties in the learning process at school

Ana Luiza Navas
Larissa de Medeiros Botecchia
Nathalia Ribeiro de Brito

INTRODUCTION

Speech-language pathology is a science that studies human communication, and its performance is related to the development, rehabilitation and improvement of oral and written language, voice, hearing, balance, speech (fluency and articulation), as well as orofacial functions (swallowing and chewing) (Brazil, 1981). Despite being considered a profession in the health area, the performance of the speech-language therapist may be related to learning, and therefore transitions between the two areas: health and education. Undoubtedly, acting with the complexity of the learning process and its difficulties, there is a need for an interdisciplinary approach. Thus, in the educational scenario, speech-language therapy develops, together with educators, actions to promote, improve and prevent difficulties that may negatively interfere in school performance, such as difficulties in socialization; in the execution of activities in class; in the development of reading and writing, and the teaching and learning process (ASHA, 2010).

Considering learning issues, the specialties of Language and Educational Speech Therapy are involved, both recognized by the Federal Council of Speech Therapy (CFFa,2010; CFFa 2006). The performance of the speech therapist covers, in this context, both clinical and educational activities, with the development of programs to prevent learning difficulties in written language, the identification and intervention of learning disorder, as well as the development of educational support and guidance programs in cases of communication disorders in general (Navas, Ciboto & Borges, 2017).

Numerous situations can generate difficulties in the learning process, which can be circumstantial or persistent (Snowling, Duff, Nash, & Hulme,2016). Students who present biomedical conditions such as genetic syndromes, intellectual disability, Autism Spectrum Disorder (ASD), hearing or visual impairment, neurological lesions, among others, may present failures in the development of oral language or learning difficulties. Besides, according to the 5th edition of the Diagnostic and Statistical Manual of Mental Disorders - DSM-5 (American Psychiatric Association,2013), Neurodevelopmental Disorders present different levels of difficulties with the learning process, some of which are specific learning disorders.

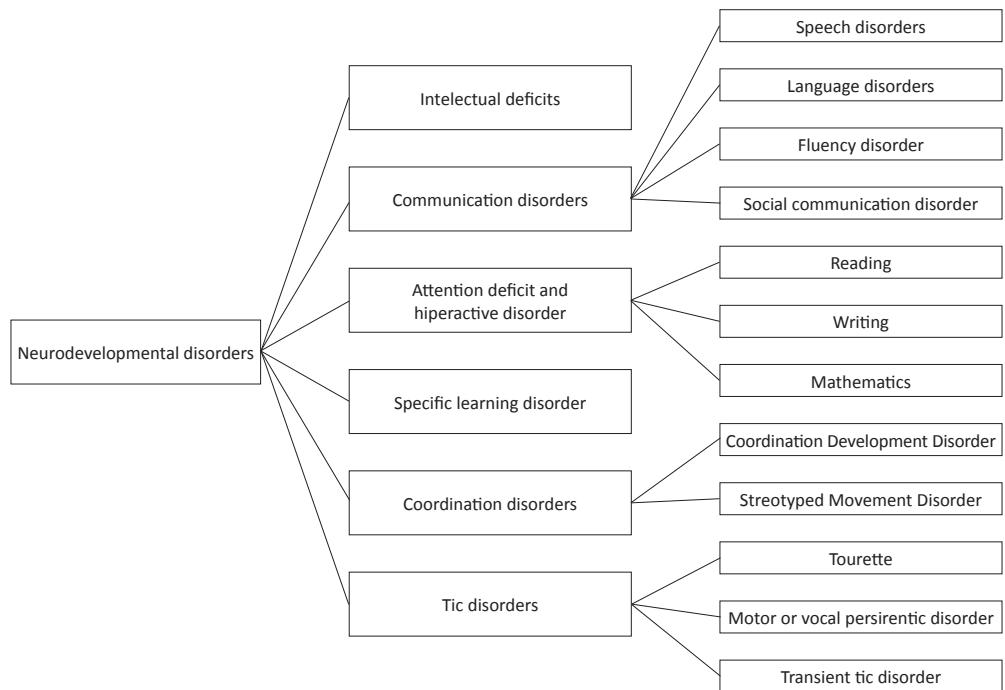


Figure 1. Diagram of Neurodevelopmental Disorders according to DSM-V (adapted)

Source: American Psychiatric Association (2013) Diagnostic and statistical manual of mental disorders, 5th ed. American Psychiatric Association, Arlington.

As described in Figure 1, Neurodevelopmental Disorders include Communication Disorders which present difficulties in oral language and speech production that may impact the process of learning how to read and write. It often also causes difficulty in understanding (receptive language) requests from teachers and expressing (expressive language) their answers, doubts, and needs (Catts et al. 2002). Among these, in Developmental Language Disorder (DLD), there is significant

impairment in the acquisition and development of oral language, in the absence of associated conditions (Bishop et al., 2017). In the case of Attention Deficit Hyperactivity Disorder (ADHD), because it presents some impairment in executive functions and oral and written language, there are reading comprehension failures. There are reports of frequent retention and school dropout that reflect difficulties in school performance when there is no necessary support (Alves, Casella & Ferraro, 2016; Bouguen, 2016).

Finally, Neurodevelopmental Disorders also include a general category called Specific Learning disorders, which include the specific manifestations of learning difficulties in three academic domains, that is, in reading, writing, and mathematics. Thus, based on well-defined criteria, specific criteria were suggested: specific learning disorder with (a) reading impairment (which corresponds to the term known as developmental dyslexia); (b) the written expression (which corresponds to the term known as dysorthography) or (c) of mathematics (which corresponds to the term known as dyscalculia) (Mousinho & Navas, 2017).

This chapter aims to discuss the performance of Speech-Language Therapy, considering the different levels of education and educational contexts, both in the school environment (Educational Speech-Language Therapy), as well as in the clinical environment, to evaluate and intervene in cases of learning difficulties in general, and especially in neurodevelopmental disorders.

THE CONTRIBUTION AND SUPPORT OF SPEECH THERAPY IN THE EDUCATIONAL CONTEXT

Initially, speech-language therapy was based on rehabilitation, and this vision guided the process of professional consolidation until it became the practice that we have today. As its identity was shaped by rehabilitation and, based on the known clinical model, several criticisms were made to speech-language therapy that supported education. However, as new laws and new performances emerged within the profession, Educational Speech-language Therapy reinvented itself by bringing perspectives of health promotion, educational actions, and assistance in activities with a focus on the best performance of students, teachers, and their institutions (Celeste et al. 2017). The basis of this action is to perform a situational diagnosis (Cavalheiro, 1997), that is, to identify relevant aspects that can contribute to the development of the work plan, considering the following points:

- a) Nature of the Institution:** Public or Private;
- b) Level of schooling:** Stages of primary education from early childhood education, elementary education I and II and high school, including the modality of teaching Youth and Adult Education (EJA) and higher education;
- c) Educational Conceptions:** What is the act of educating, how you intend to train people;
- d) Methodologies applied;**
- e) Organization and management:** Know all the areas that exist on site, the infrastructure, the conditions;

f) Daily routine: To know the routine of students, teachers, coordinators, and principals.

Recognizing the above characteristics can expand the work and allows the speech-language therapist to plan his or her actions in numerous possibilities (CFFa,2015) to support the learning process, such as:

- to emphasize the importance and promote discussions on the precursors of literacy and development of competence in reading and writing;
- develop educational and informative actions for parents, students, and teachers;
- guide parents/guardians on language development;
- participate in the continuing training of teachers;
- guide on practices and strategies in classrooms; participate in discussions on tests adaptations and materials;
- health promotion in the areas of language, voice, hearing, eating, inclusion, and communication.

All these possibilities demonstrate a set of actions that will promote knowledge, generate skills, and propose interdisciplinary work among teachers, coordinators, and educational speech-language therapists, focusing on improving the process of learning. However, in the context of learning difficulties and specific learning disorders, we should emphasize the importance of the orientation of the school team, suggesting to parents that the student can be referred to specialists, who will research and investigate the existence of a possible diagnosis.

Brazil has made significant progress in discussing accessibility in the education system and has created opportunities for inclusion programs for students with special needs in Regular Education systems. The publication of the Statute of Persons with Disabilities and following the approval of the Brazilian Law on the Inclusion of Persons with Disabilities (BRASIL, LBI - Law No. 13,146, of July 6, 2015) incorporates an essential change in the concept of disability, no longer with specific audiences, but in situations of permanent or temporary difficulties. What matters is to reduce the barriers and obstacles to learning, ensuring the linguistic and cognitive adaptations necessary to meet all students, regardless of the difficulty presented (Mousinho, Santos & Navas, 2017). The literature has pointed out numerous benefits of the speech-language therapist's performance to high school and higher education students, either in cases that have learning difficulties or in specific cases of neurodevelopmental disorders (Ehren, 2002). This would be another example of how the educational speech therapist can participate in the interdisciplinary team and assist in the development of an individual plan for students in high school or higher education. This support is particularly important and can mean minimizing the dropout of these students from the educational system.

THE CONTRIBUTION AND SUPPORT OF SPEECH THERAPY IN THE CLINICAL CONTEXT

When children or young people with learning difficulties are identified in the school context, it is necessary to follow up on these difficulties

through pedagogical interventions. If these difficulties persist even after programs to strengthen some skills in the school context, referral for a detailed diagnostic evaluation should be considered, and if necessary, to plan a specialized intervention in the clinical context. Such an approach of early identification of learning difficulties is used, as educational policy in several countries, and is called Response to Intervention (Fuchs & Fuchs, 2007; Silva, Luz, Mousinho, 2012; Mousinho & Navas, 2016).

In this clinical scenario, the speech-language therapist acts in the evaluation of students with complaints of learning difficulties, composing the multidisciplinary team that performs the diagnostic investigation. His or her performance is also in the rehabilitation and strengthening of oral and written language skills that directly impact the academic and social performance of these students. For this, the speech-language therapist considers the difficulties and skills that the person has, verifies, which skill needs to be improved, and from this analysis, an individualized therapeutic plan is elaborated.

It is also considered that acquisitions follow a sequence, and without one of the previous skills (prerequisites), it is challenging for the child to advance to the learning of the next skill. Thus, if the child does not yet know the letters, we cannot expect him to read words; if having difficulty understanding explicit questions (i.e., information present in the text), answers to implicit questions may be impossible. If one still cannot produce or change a speech sound, it will be difficult representing it correctly in writing (Artemis, Papadimitriou & Vlachos, 2014; McNeill, Wolter, & Gillon, 2017).

In cases of learning difficulties and specific learning disorders, the speech-language therapist stimulates precursor skills for the development of reading and writing, involving processing skills at the phonological level. Among these skills is phonological awareness, that is, the manipulation of speech segments (words, syllables, and phonemes), phonological memory, and rapid naming (Bar-Kochva, & Nevo, 2019). It also performs activities aimed at improving the relationship between letters and sounds (grapheme-phoneme) in reading and sounds and letters (phoneme-grapheme) in writing, to improve decoding (Dehaene-Lambertz, 2015). As a consequence, that makes reading faster and more accurate, allowing it to become more automatic, which in turn improves reading comprehension (Milne, 2005). Together, it performs tasks that seek to improve text comprehension (Cunha et al., 2012), using strategies such as the identification of characters, primary and secondary ideas, establishing cause and effect relationships, use of previous knowledge, among others (Castillo, 1999).

The clinical professional knows in-depth each of the cases he or she attends. Thus, the interaction with educational speech-language therapists and, undoubtedly, with the school team, is fundamental to enhance the development of students who present learning difficulties and disorders. Therefore, may direct, guide, and propose adaptations necessary and pertinent to the reality of each student, showing once again the importance of interdisciplinarity.

FINAL CONSIDERATIONS

Specifically, regarding the support of speech-language therapy, we present the perspective of direct action in the educational context and indirectly in the clinical environment. In the educational context, the concern with early stimulation of skills that are predictors of excellent learning performance is one of the support actions for the prevention of learning difficulties in reading and writing. The development of oral language can be stimulated from preschool until high school, ensuring a solid basis both for the early stages of literacy, but also in the more advanced years, improving performance in reading comprehension and writing texts. Besides, speech-language therapy can act in support programs for students with neurodevelopmental disorders, always in partnership with the educational team, such as support for the adaptation of materials and tests.

In the clinical context, the speech-language therapist acts in the specialized intervention process. When the complaint revolves around learning difficulties, this work should maintain a constant and robust communication beyond the family, involving the education professionals who accompany the child.

Finally, we would like to highlight the essential nature of interdisciplinarity for the support of children and young people with learning difficulties. The exchange of knowledge and discussions involving various perspectives only enriches and qualifies the work to enhance the learning of all students.

REFERENCES

- American Psychiatric Association (2013) Diagnostic and statistical manual of mental disorders, 5th ed. American Psychiatric Association, Arlington.
- Alves, D, Casella, EB, & Ferraro, AA. (2016). Desempenho ortográfico de escolares com dislexia do desenvolvimento e com dislexia do desenvolvimento associado ao transtorno do déficit de atenção e hiperatividade (Spelling performance of students with developmental dyslexia and developmental dyslexia associated with attention deficit hyperactivity disorder). CoDAS, 28(2), 123-131.
- Artemis M. Papadimitriou and Filippou M. Vlachos, Which specific skills developing during preschool years predict the reading performance in the first and second grade of primary school? (2014). Early Child Development and Care, 184(11): 1706-1722. 10.1080/03004430.2013.875542,
- American Speech-Language-Hearing Association. (2010). Roles and responsibilities of speech-language pathologists in schools [Professional Issues Statement]. Available from www.asha.org/policy.
- Bar-Kochva, I., & Nevo, E. (2019) The relations of early phonological awareness, rapid-naming and speed of processing with the development of spelling and reading: a longitudinal examination. Journal of Research in Reading, 42: 97–122. <https://doi.org/10.1111/1467-9817.12242>.
- Bishop, DVM, Snowling, MJ, Thompson, PA, Greenhalgh, T and the CATALISE-2 consortium. Phase 2 of CATALISE: a multinational and multidisciplinary Delphi consensus study of problems with language development: Terminology. J Child Psychol Psychiatr. 2017. doi:10.1111/jcpp.12721
- Bouguen, A. (2016) Adjusting content to individual student needs: Further evidence from an in-service teacher training program. Economics of Education Review, 50: 90–112.
- BRASIL. Lei nº 6965, de 09 de dezembro de 1981. Dispõe sobre a regulamentação da profissão de Fonoaudiólogo, e determina outras providências (Provides for the regulation of the speech therapist profession, and determines other measures). Disponível em: <https://presrepublica.jusbrasil.com.br/legislacao/129429/lei-6965-81>
- BRASIL, Lei nº 13.146, de 06 de julho de 2015. Institui a Lei Brasileira de Inclusão da Pessoa com Deficiência (Estatuto da Pessoa com Deficiência) (

Institutes the Brazilian Law for Inclusion of Persons with Disabilities). Disponível em: < http://www.planalto.gov.br/ccivil_03/_Ato2015-2018/2015/Lei/L13146.htm>.

Castillo, H.V. (1999). A leitura de textos literários vs textos científicos por leitores incipientes (The reading of literary texts vs scientific texts by incipient readers) (pp. 55-64). São Paulo: Alínea.

Catts, H.W., Fey, M.E., Tomblin, J.B., & Zhang, X. (2002). A longitudinal investigation of reading outcomes in children with language impairments. *Journal of Speech, Language, and Hearing Research*, 45, 1142-1157. [https://doi.org/10.1044/1092-4388\(2002/093\)](https://doi.org/10.1044/1092-4388(2002/093)).

Cavalheiro MTP. Trajetórias e possibilidades de atuação do fonoaudiólogo na escola (Trajectories and possibilities of performance of the speech therapist at school). In: Lagrotta MGM, César CPHAR. *A Fonoaudiologia nas instituições*. São Paulo: Lovise; 1997. p. 81-8.

Celeste, L. C. et al. Mapeamento da Fonoaudiologia Educacional no Brasil: formação, trabalho e experiência profissional (Mapping of Educational Speech Therapy in Brazil: training, work and professional experience). CoDAS, São Paulo, 29(1): e20160029, 2017. Disponível em: <https://doi.org/10.1590/2317-1782/20172016029>.

CONSELHO FEDERAL de FONOAUDIOLOGIA. Contribuições do Fonoaudiólogo Educacional para seu Município e sua Escola, de abril de 2015. Disponível em: <https://www.fonoaudiologia.org.br/cffa/wp-content/uploads/2015/04/cartilha-fono-educacional-20151.pdf>

CONSELHO FEDERAL de FONOAUDIOLOGIA. Resolução nº 387, de 18 de setembro de 2010. Disponível em: https://www.fonoaudiologia.org.br/resolucoes/resolucoes_html/CFFa_N_387_10.htm

CONSELHO FEDERAL de FONOAUDIOLOGIA. Resolução nº 382, de 20 de março de 2010. Disponível em: https://www.fonoaudiologia.org.br/resolucoes/resolucoes_html/CFFa_N_382_10.htm

CONSELHO FEDERAL de FONOAUDIOLOGIA. Resolução nº 320, de 16 de fevereiro de 2006. “Dispõe sobre as especialidades reconhecidas pelo Conselho Federal de Fonoaudiologia, e dá outras providências.” Disponível em: https://www.fonoaudiologia.org.br/resolucoes/resolucoes_html/CFFa_N_320_06.htm

Cunha, V. K. O., Silva, C., Capellini, S. A. Correlação entre habilidades básicas de leitura e compreensão de leitura (Correlation between basic reading skills and reading comprehension). *Estudos de Psicologia*. (2012). 29(Supl.):799-807.

Dehaene-Lambertz G, Monzalvo K. How reading acquisition changes children's spoken language network. *Brain & Language*. 2013; 127:356–365.

Ehren, B. J. Speech-language pathologists contributing significantly to the academic success of high school students: A vision for professional growth. *Topics in Language Disorders*, 22 (2): 60–80, 2002.

Fuchs LS, Fuchs DA. Model for implementing responsiveness to intervention. *Teach Except Child*. 2007;39(5):14-20. DOI: 10.1177/004005990703900503

McNeill, B. C., Wolter, J., & Gillon, G. T. (2017). A Comparison of the Metalinguistic Performance and Spelling Development of Children with Inconsistent Speech Sound Disorder and Their Age-Matched and Reading-Matched Peers. *American Journal of Speech-Language Pathology*, 26(2), 456–468. https://doi.org/10.1044/2016_AJSLP-16-0085

Milne, D. (2005). *Teaching the brain to read*. Artarmon: SK Publishing.

Mousinho, R., & Navas, A.L.G.P. (2016). Mudanças apontadas no DSM-5 em relação aos transtornos específicos de aprendizagem em leitura e escrita (Changes pointed out in DSM-5 in relation to specific learning disorders in reading and writing). *Rev Deb Psiq*, 6(3), 38-45.

Mousinho, R.; Santos, MTM; Navas, ALGP. Desenho Universal para a aprendizagem: desenvolvendo as habilidades de leitura e escrita para que todos aprendam (Universal Design for Learning: Developing Reading and Writing Skills for Everyone to Learn). In: *Guia Prático de Neuroeducação*. Rio de Janeiro: WAK, 2017, (1): 99-124.

Navas, A.L.G.P., Ciboto, T., Borges, J.P.A. (2017). Reading Disorders and the Role of Speech-Language Pathologists. In *Advances in Speech-language Pathology*, Fernanda Dreux M. Fernandes, IntechOpen, DOI: 10.5772/intechopen.70234. Available from: <https://www.intechopen.com/books/advances-in-speech-language-pathology/reading-disorders-and-the-role-of-speech-language-pathologists>

Silva B, Luz T, Mousinho, R. (2012). A eficácia das oficinas de estimulação em um modelo de resposta à intervenção (The effectiveness of stimulation workshops in an intervention response model). *Rev Psicopedag*. 29(88):15-24.

Snowling, M.J., Duff, F.J., Nash, H.M., & Hulme, C. (2016). Language profiles and literacy outcomes of children with resolving, emerging, or persisting language impairments. *Journal of Child Psychology and Psychiatry*, 57: 1360-1369.

CHAPTER 13

Environmental enrichment as an intervention in an animal model to improve cognition

Thaís Terpins Ravache

Alice Batistuzzo

Fernanda Beraldo Lorena

Bruna Pascarelli Pedrico do Nascimento

Marllos Eduardo da Silva Brandão

Juliana Midori Sato

Miriam Oliveira Ribeiro

Behavior is the result of the interaction between genes and the environment. Showing the importance of both the genes and the environment in determining human behavior. However, the environment can also modulate the behavior by processes of learning and forming memories. Thus, the ability to learn something new and store this information is a fundamental part of proper development.

Learning is the process by which we acquire knowledge about the world, while memory is the ability to store and use this information in our daily lives. Thus, memory allows us to modulate our behavior based on previous experiences. The process of memory formation is divided into 3 phases: 1) Acquisition, which is when the information reaches the Central Nervous System (CNS) through a sensory pathway such as smell,

vision, hearing and touch; 2) Storage / Consolidation, when final memory occurs and 3) Evocation, the process of recovering the memory after its consolidation (11). Memory consolidation and evocation are influenced by several factors, such as the development of the SNC, how the acquisition process takes place and the environmental context (Dudai, Karni, & Born, 2015).

PHYSIOLOGICAL PROCESSES INVOLVED IN MEMORY FORMATION

The hippocampus and parahippocampal structures, perirhinal and entorhinal cortex, are fundamental to the process of memory consolidation. The role of the hippocampus and its adjacent structures in memory process was discovered in the 1950s based on studies describing the case of the patient H.M., who suffered a bilateral ablation of the medial temporal lobe in 1953. Soon after the surgery, when the hippocampus, the perirhinal and entorhinal cortex were removed, the H.M. patient was no longer able to form new memories, the so-called anterograde amnesia. Remarkably, all the memories before the surgery were preserved (Milner, Corkin, & Teuber, 1968; Scoville & Milner, 1957).

H.M. was not the only case, as Penfield and Milner described several cases in 1958 of medial temporal lobe ablation surgeries, whose patients developed a very similar disorder as the one observed in H.M. (Penfield & Milner, 1958).

The hippocampus, more precisely the dentate gyrus, exhibits a process of great relevance, the neurogenesis. Many studies have suggested

that neurogenesis is a fundamental process for processing and storing memory (for review see (Kozareva, Cryan, & Nolan, 2019)). Thus, it is possible that if we can modulate and stimulate hippocampal neurogenesis, we will be able to improve the learning processes in younger individuals and even prevent the memory loss observed with aging.

What are the regulators of the hippocampal neurogenesis process and how can we activate this process in order to improve cognitive abilities?

In 1997, Kempermann et al. published the first study showing that environmental enrichment can stimulate hippocampal neurogenesis. In this study, mice were exposed to more complex environments with larger cages containing tunnels and toys, as opposed to standard cages where animals are normally kept. The exposure of animals to the enriched environment significantly improved their memory and learning, as well as increased the proliferation of neurons in the dentate gyrus (Bruel-Jungerman, Laroche, & Rampon, 2005; Kempermann, 2019; Kempermann et al., 1997; Nilsson, Perfilieva, Johansson, Orwar, & Eriksson, 1999).

ENVIRONMENTAL ENRICHMENT AS AN INTERVENTION TOOL

EE refers to a behavioral intervention technique that aims to increase the animal's psychological and physiological well-being. It can be used in different contexts that explores different types of stimuli. Initially recognized by Yerkes (1925) and later by Hediger (1950) (Hediger, 2013a, 2013b, 2013c; Yerkes, 1925), this technique was developed to offer to animal in captivity conditions that stimulate its natural behavior, help-

ing to prevent abnormal behaviors, known as stereotyped behaviors. It also reduces the expression of fear and aggression behavior, normalize reproductive functions and increases the animal's motivation.

This technique has also been shown to be effective in zoos. The captive environment has become an important tool for the conservation and maintenance of many species. Studies have shown that offering resources such as different objects promotes exploratory behaviors and social interaction, in addition to reducing self-directed behaviors (Regaiolli et al., 2020; Regaiolli et al., 2019).

In humans, EE also has important implications in the context of well-being and lifestyle. Behavioral interventions such as physical and social activities reduce the aging process and cognitive decline (Phillips, 2017; Sampedro-Piquero & Begega, 2017). All these interventions are beneficial for the CNS, as they stimulate hippocampal neurogenesis in adults increasing the number of new neurons in the dentate gyrus (Phillips 2017). In addition to neurogenesis, the brain exhibits a process called neuroplasticity. In this process, the brain changes due to interactions with the environment, exhibiting structural modifications such as the regeneration of axons and dendrites in the peripheral and central nervous system and the establishment of new connections between neurons, which results in the refinement and/or maintenance of diverse skills (Phillips, 2017; Regaiolli et al., 2019; Rogge, Roder, Zech, & Hotting, 2018).

Understanding the mechanisms that are involved in the benefits of environmental enrichment is important to build strategies that seek to prevent, delay and mitigate cognitive and motor impairments observed

in humans. Animal models provide a faster and more elaborate investigation when compared to studies in humans. Thus, the use of animal models aims to understand how these stimuli interfere in the structure and function of the brain and how this is reflected in their behavior and quality of life (Sampedro-Piquero & Begega, 2017).

EFFECT OF EE IN ANIMAL MODELS

The EE used in animal models can consist of several stimuli, such (van Praag, Kempermann, & Gage, 2000; Zimmermann, Stauffacher, Langhans, & Wurbel, 2001):

- 1) Physical enrichment:** in which there is the introduction of materials in the enclosure that stimulate activities in their natural environment, such as the introduction of burrows and tunnels;
- 2) Sensory enrichment:** which consists in stimulating the animal's senses, such as introducing herbs to stimulate the sense of smell and the presentation of objects with different textures and temperatures to stimulate touch;
- 3) Cognitive enrichment:** challenges for the animal in an increasing level of difficulty, such as hiding snacks or making access to them more difficult;
- 4) Social enrichment:** it can be intra or inter-specific, favoring social relations such as establishing hierarchy, and territory, among others;
- 5) Food Enrichment:** consists of modifications in the animal's diet, such as frequency of feeding, the time and type of handling in which the food is offered;

6) Physical exercise: increasing the animal's physical activity, with the introduction of repetitive exercises on a treadmill and / or exercise wheel, as well as activities to overcome obstacles.

ANIMAL MODELS AND THE STUDY OF EE

Animals that do not express Beta3 (Arβ3) adrenergic receptors.

Many neurotransmitters are involved in the memory consolidation process, including the noradrenaline (NE) (Izquierdo & Medina, 1997; Lu, Pang, & Woo, 2005; McDonald & White, 2013; McGaugh, 2015). NE remains high in the SNC throughout the day, participating in the process of memory acquisition and consolidation. In addition, NE also participates in facilitating the formation of memory from stimuli with emotional valence with increased attention levels and when the release of NE reaches its highest levels (Berridge, Schmeichel, & Espana, 2012; Liddell et al., 2005; Samuels & Szabadi, 2008; Sara & Bouret, 2012).

Beta adrenergic receptors (Arβ) are recognized for their important role in the process of consolidating memory and learning (Cammarota et al., 2008). Mice that do not express the Arβ subtype, the β3-type adrenergic receptor (Arβ3), exhibit deficits in short and long-term memory (Souza-Braga et al., 2018).

These animals, called Arβ3KO, are a good model to assess whether the EE is efficient in correcting learning disabilities in animals with already established cognitive impairments. Thus, we adapted a protocol and studied Arβ3KO animals submitted to the EE protocol. The protocol

consisted of routine of sensory, cognitive, feeding and physical changes in the environment for 8 weeks (Huttenrauch, Salinas, & Wirths, 2016; Simpson & Kelly, 2011). The results were very encouraging, as the EE completely corrected the impairments in learning and memory exhibited by the animals. These promising results were observed in animals that were stimulated by the EE right after the weaning of the mice, around the 21st day of age, which corresponds in humans to ~6 months of age. These animals remained in the EE for 8 weeks, that is, until 85 days of age, which corresponds in humans to ~20 years of age. We can infer that the period studied in animals corresponds to almost the total amount of time that human beings remain in school. These data show the importance of the school period in the cognitive processes of individuals.

Is the age of the animal when EE is applied relevant to its success? Therefore, we submitted 4 month old animals on the same EE protocol, enriched for 8 weeks. This means that Ar β 3KO mice remained from 4 to 6 months of age being stimulated with the EE protocol, age that corresponds between the period of ~ 33 to 53 years in humans. The results obtained showed that the exposure to EE later in life was not able to reverse the cognitive impairments of the Ar β 3KO animals. The data obtained in this study suggest that the EE protocol was able to reverse the impairment in memory of young AR β 3KO mice, but in adult AR β 3KO mice this protocol was not efficient in reversing memory deficits. This suggests that there is a time frame for the environmental stimulation of the CNS for it to be successful.

Gestational hypothyroidism: Hypothyroidism is the most common thyroid dysfunction in pregnancy and its impact on the development of offspring is well known. Adequate lack of thyroid hormone during pregnancy leads to failures in the differentiation of nerve cells, inadequate development of the central nervous system, increased risk of perinatal defects, low birth weight and impacts on motor and cognitive development (Morreale de Escobar, Obregon, & Escobar del Rey, 2004; Segni, 2000; Springer, Jiskra, Limanova, Zima, & Potlukova, 2017). Several studies with rats and mice have shown that maternal hypothyroidism impairs cognitive functions in the offspring, reducing operational memory and spatial learning (Chakraborty et al., 2012; Liu et al., 2010; Opazo et al., 2008; Shafiee, Vafaei, & Rashidy-Pour, 2016).

The induction of clinical gestational hypothyroidism in female rats resulted in offspring of males with normal physical development. However, at 30 days of age the animals showed impairment in cognition and increased anxiety and depressive patterns of behaviors. These results confirm that the lack of thyroid hormone during pregnancy has a profound impact on the development of offspring. In an attempt to try to reverse these effects in the offspring's of hypothyroid mothers, we submitted the animals to the EE protocol for 8 weeks from 2 months of age, which corresponds to ~ 20 years of age in humans. EE corrected the cognitive impairment and reduced the depressive and anxious behavior. Thus, these data suggest that EE applied to young adult animals is able to reduce damage induced by lack of thyroid hormone during pregnancy.

FINAL CONSIDERATIONS

The environmental enrichment technique has been considered as an alternative to reverse deficits in the memory formation, a key step in the learning process. The results found in the literature show that this intervention is promising to suggest that by adding activities that require a greater cognitive effort than that usually required in the environment, it is possible to reverse cognitive impairments, and they can be extrapolated to human behavior. However, studies published so far have been shown that EE is more effective when administered during childhood and young age, and it is still unclear whether the AE applied to adults is capable of reversing impairments in cognition. The translation data obtained in animal models to human beings reinforces the importance of several stimuli in the period that includes schooling.

REFERENCES

- Berridge, C. W., Schmeichel, B. E., & Espana, R. A. (2012). Noradrenergic modulation of wakefulness/arousal. *Sleep Med Rev*, 16(2), 187-197. doi:10.1016/j.smrv.2011.12.003
- Bruel-Jungerman, E., Laroche, S., & Rampon, C. (2005). New neurons in the dentate gyrus are involved in the expression of enhanced long-term memory following environmental enrichment. *Eur J Neurosci*, 21(2), 513-521. doi:10.1111/j.1460-9568.2005.03875.x
- Cammarota, M., Bevilaqua, L. R., Rossato, J. I., Lima, R. H., Medina, J. H., & Izquierdo, I. (2008). Parallel memory processing by the CA1 region of the dorsal hippocampus and the basolateral amygdala. *Proc Natl Acad Sci U S A*, 105(30), 10279-10284. doi:10.1073/pnas.0805284105
- Chakraborty, G., Magagna-Poveda, A., Parratt, C., Umans, J. G., MacLusky, N. J., & Scharfman, H. E. (2012). Reduced hippocampal brain-derived neurotrophic

factor (BDNF) in neonatal rats after prenatal exposure to propylthiouracil (PTU). *Endocrinology*, 153(3), 1311-1316. doi:10.1210/en.2011-1437

Dudai, Y., Karni, A., & Born, J. (2015). The Consolidation and Transformation of Memory. *Neuron*, 88(1), 20-32. doi:10.1016/j.neuron.2015.09.004

Hediger, H. (2013a). 8 - Quality of the Environment. In H. Hediger (Ed.), *Wild Animals in Captivity* (pp. 71-77): Butterworth-Heinemann.

Hediger, H. (2013b). 9 - Exogenous Factors: Physical Environment. In H. Hediger (Ed.), *Wild Animals in Captivity* (pp. 78-97): Butterworth-Heinemann.

Hediger, H. (2013c). 10 - Exogenous Factors: Biological Environment. In H. Hediger (Ed.), *Wild Animals in Captivity* (pp. 98-119): Butterworth-Heinemann.

Huttenrauch, M., Salinas, G., & Wirths, O. (2016). Effects of Long-Term Environmental Enrichment on Anxiety, Memory, Hippocampal Plasticity and Overall Brain Gene Expression in C57BL6 Mice. *Front Mol Neurosci*, 9, 62. doi:10.3389/fnmol.2016.00062

Izquierdo, I., & Medina, J. H. (1997). Memory formation: the sequence of biochemical events in the hippocampus and its connection to activity in other brain structures. *Neurobiol Learn Mem*, 68(3), 285-316. doi:10.1006/nlme.1997.3799

Kempermann, G. (2019). Environmental enrichment, new neurons and the neurobiology of individuality. *Nat Rev Neurosci*, 20(4), 235-245. doi:10.1038/s41583-019-0120-x

Kempermann, G., Kuhn, H. G., & Gage, F. H. (1997). More hippocampal neurons in adult mice living in an enriched environment. *Nature*, 386(6624), 493-495. doi:10.1038/386493a0

Kozareva, D. A., Cryan, J. F., & Nolan, Y. M. (2019). Born this way: Hippocampal neurogenesis across the lifespan. *Aging Cell*, 18(5), e13007. doi:10.1111/acel.13007

Liddell, B. J., Brown, K. J., Kemp, A. H., Barton, M. J., Das, P., Peduto, A.,... Williams, L. M. (2005). A direct brainstem-amygdala-cortical 'alarm' system for subliminal signals of fear. *Neuroimage*, 24(1), 235-243. doi:10.1016/j.neuroimage.2004.08.016

Liu, D., Teng, W., Shan, Z., Yu, X., Gao, Y., Wang, S.,... Zhang, H. (2010). The effect of maternal subclinical hypothyroidism during pregnancy on brain development in rat offspring. *Thyroid*, 20(8), 909-915. doi:10.1089/thy.2009.0036

Lu, B., Pang, P. T., & Woo, N. H. (2005). The yin and yang of neurotrophin action. *Nat Rev Neurosci*, 6(8), 603-614. doi:10.1038/nrn1726

McDonald, R. J., & White, N. M. (2013). A triple dissociation of memory systems: Hippocampus, amygdala, and dorsal striatum. *Behav Neurosci*, 127(6), 835-853. doi:10.1037/a0034883

McGaugh, J. L. (2015). Consolidating memories. *Annu Rev Psychol*, 66, 1-24. doi:10.1146/annurev-psych-010814-014954

Milner, B., Corkin, S., & Teuber, H. L. (1968). Further analysis of the hippocampal amnesia syndrome: 14-year follow-up study of H.M. *Neuropsychologia*, 6(3), 215-234. doi:[https://doi.org/10.1016/0028-3932\(68\)90021-3](https://doi.org/10.1016/0028-3932(68)90021-3)

Morreale de Escobar, G., Obregon, M. J., & Escobar del Rey, F. (2004). Role of thyroid hormone during early brain development. *Eur J Endocrinol*, 151 Suppl 3, U25-37. doi:10.1530/eje.0.151u025

Nilsson, M., Perfilieva, E., Johansson, U., Orwar, O., & Eriksson, P. S. (1999). Enriched environment increases neurogenesis in the adult rat dentate gyrus and improves spatial memory. *J Neurobiol*, 39(4), 569-578. doi:10.1002/(sici)1097-4695(19990615)39:4<569::aid-neu10>3.0.co;2-f

Opazo, M. C., Gianini, A., Pancetti, F., Azkconea, G., Alarcon, L., Lizana, R.,... Riedel, C. A. (2008). Maternal hypothyroxinemia impairs spatial learning and synaptic nature and function in the offspring. *Endocrinology*, 149(10), 5097-5106. doi:10.1210/en.2008-0560

Penfield, W., & Milner, B. (1958). Memory deficit produced by bilateral lesions in the hippocampal zone. *AMA Arch Neurol Psychiatry*, 79(5), 475-497. doi:10.1001/archneurpsyc.1958.02340050003001

Phillips, C. (2017). Physical Activity Modulates Common Neuroplasticity Substrates in Major Depressive and Bipolar Disorder. *Neural Plast*, 2017, 7014146. doi:10.1155/2017/7014146

Regaiolli, B., Angelosante, C., Marliani, G., Accorsi, P. A., Vaglio, S., & Spiezio, C. (2020). Gum feeder as environmental enrichment for zoo marmosets and tamarins. *Zoo Biol*, 39(2), 73-82. doi:10.1002/zoo.21531

Regaiolli, B., Rizzo, A., Ottolini, G., Miletto Petrazzini, M. E., Spiezio, C., & Agrillo, C. (2019). Motion Illusions as Environmental Enrichment for Zoo Animals: A

Preliminary Investigation on Lions (*Panthera leo*). *Front Psychol*, 10, 2220. doi:10.3389/fpsyg.2019.02220

Rogge, A. K., Roder, B., Zech, A., & Hotting, K. (2018). Exercise-induced neuroplasticity: Balance training increases cortical thickness in visual and vestibular cortical regions. *Neuroimage*, 179, 471-479. doi:10.1016/j.neuroimage.2018.06.065

Sampedro-Piquero, P., & Begega, A. (2017). Environmental Enrichment as a Positive Behavioral Intervention Across the Lifespan. *Curr Neuropharmacol*, 15(4), 459-470. doi:10.2174/1570159x14666160325115909

Samuels, E. R., & Szabadi, E. (2008). Functional neuroanatomy of the noradrenergic locus coeruleus: its roles in the regulation of arousal and autonomic function part I: principles of functional organisation. *Curr Neuropharmacol*, 6(3), 235-253. doi:10.2174/157015908785777229

Sara, S. J., & Bouret, S. (2012). Orienting and reorienting: the locus coeruleus mediates cognition through arousal. *Neuron*, 76(1), 130-141. doi:10.1016/j.neuron.2012.09.011

Scoville, W. B., & Milner, B. (1957). Loss of recent memory after bilateral hippocampal lesions. *J Neurol Neurosurg Psychiatry*, 20(1), 11-21. doi:10.1136/jnnp.20.1.11

Segni, M. (2000). Disorders of the Thyroid Gland in Infancy, Childhood and Adolescence. In K. R. Feingold, B. Anawalt, A. Boyce, G. Chrousos, K. Dungan, A. Grossman, J. M. Hershman, G. Kaltsas, C. Koch, P. Kopp, M. Korbonits, R. McLachlan, J. E. Morley, M. New, L. Perreault, J. Purnell, R. Rebar, F. Singer, D. L. Treince, A. Vinik, & D. P. Wilson (Eds.), *Endotext*. South Dartmouth (MA): MDText.com, Inc.

Shafiee, S. M., Vafaei, A. A., & Rashidy-Pour, A. (2016). Effects of maternal hypothyroidism during pregnancy on learning, memory and hippocampal BDNF in rat pups: Beneficial effects of exercise. *Neuroscience*, 329, 151-161. doi:10.1016/j.neuroscience.2016.04.048

Simpson, J., & Kelly, J. P. (2011). The impact of environmental enrichment in laboratory rats--behavioural and neurochemical aspects. *Behav Brain Res*, 222(1), 246-264. doi:10.1016/j.bbr.2011.04.002

Souza-Braga, P., Lorena, F. B., Nascimento, B. P. P., Marcelino, C. P., Ravache, T. T., Ricci, E.,..., Ribeiro, M. O. (2018). Adrenergic receptor beta3 is involved in the memory consolidation process in mice. *Braz J Med Biol Res*, 51(10), e7564. doi:10.1590/1414-431X20187564

Springer, D., Jiskra, J., Limanova, Z., Zima, T., & Potlukova, E. (2017). Thyroid in pregnancy: From physiology to screening. *Crit Rev Clin Lab Sci*, 54(2), 102-116. doi:10.1080/10408363.2016.1269309

van Praag, H., Kempermann, G., & Gage, F. H. (2000). Neural consequences of environmental enrichment. *Nat Rev Neurosci*, 1(3), 191-198. doi:10.1038/35044558

Yerkes, R. M. (1925). *Almost human*. London, England: Century/Random House UK.

Zimmermann, A., Stauffacher, M., Langhans, W., & Wurbel, H. (2001). Enrichment-dependent differences in novelty exploration in rats can be explained by habituation. *Behav Brain Res*, 121(1-2), 11-20. doi:10.1016/s0166-4328(00)00377-6

CHAPTER 14

Development of a resilience program for adolescents in a school setting

Tatiana Matheus Pinto
Elizeu Coutinho de Macedo

This chapter presents a brief history of the development of the concept of resilience in the field of psychology and its current definition. After this initial conceptualization, some strategies for promoting resilience and, more specifically, the characteristics and effectiveness of resilience intervention programs for children and adolescents are summarized. Based on scientific evidence reported in systematic reviews on resilience promotion strategies, the structure of a resilience program developed by the authors for implementation in schools is presented. Finally, the chapter concludes with some thoughts on the importance of the school setting in promoting resilience among children and adolescents; future directions and possible short- and long-term benefits of resilience processes are also discussed.

PSYCHOLOGICAL RESILIENCE

In the 1970s, the first studies on psychological resilience approached the concept of resilience as an intrinsic and immutable trait. Resilience was understood as a synonym for invulnerability to adversity and chal-

lenges throughout the individual's life trajectory. This meaning of the concept has changed over the years, mainly due to the advancement of knowledge in the field of human development sciences. Given that human development is influenced by various non-linear and dynamic systems, resilience has also come to be understood as a complex and dynamic characteristic that can undergo modifications depending, not only on personality aspects and individual cognitive skills, but also on the interactions between subjects and their environment (Masten & Barnes, 2018).

The American Psychological Association currently defines resilience as the ability to recover and adapt to adverse situations, trauma, threats, or significant sources of stress. Resilience is influenced by cognitive, attitudinal, and behavioral aspects of the individual. The individual's capacity for resilience can thus be expanded with the help of structured strategies that develop these aspects (Palmiter, Alvord, Dorlen, Comas-Diaz, Luthar, Maddi, O'Neill, Saakvitne, & Tedeschi, 2020).

In general, strategies that promote resilience seek to mitigate possible risk factors that give rise to maladaptive adjustments and strengthen protective factors, which contribute to a positive result and greater adaptation (Masten & Barnes, 2018). Both risk factors and protective factors can be external to individuals, such as greater or lesser financial stability and social support, or internal to individuals, such as personality characteristics and individual cognitive ability (Laird, Krause, Funes, & Lavretsky, 2019).

Some of the main risk factors for the development and adaptive functioning of children and young people are traumas, such as sexual

abuse, loss of parents, situations of neglect, poverty, natural disasters, or wars. Protective factors, on the other hand, may involve the establishment of good quality relationships, school engagement, connection with others, coping skills, problem solving, emotional regulation, self-efficacy, optimization and hope, perception of the meaning of life, and establishing routines (Masten & Barnes, 2018).

Besides reducing the risk of possible non-adaptive outcomes, implementing strategies that strengthen these protective factors could thus also promote the individual's resilience capacity and positive attitude and adaptability. Figure 1 schematically illustrates how the strategy of these strategies work, contributing to adaptive behavior.

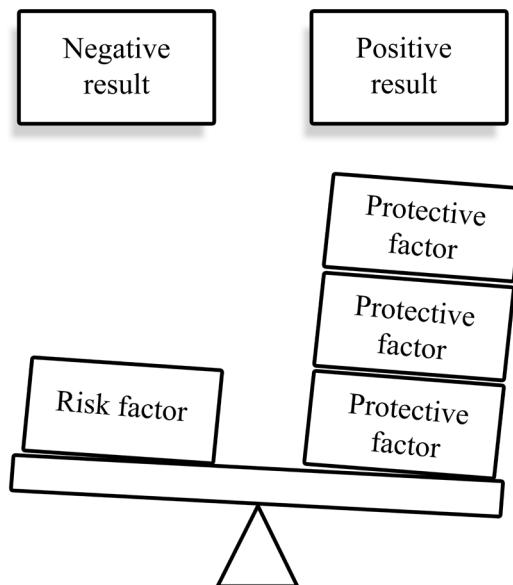


Figure 1. Strategies that seek to promote the individual's resilience capacity by strengthening protective factors

PROMOTING RESILIENCE IN CHILDREN AND ADOLESCENTS

Since resilience is dynamic, and multidimensional, and is a product of the interaction between risk and protective factors, it could be developed by promoting protective factors, in other words, resources that help individuals obtain positive results and adaptive behaviors, especially in adverse situations (Laird et al., 2019; Masten, 2018).

A study that followed the life trajectory of more than 600 children in situations of social vulnerability demonstrates how resilience capacity evolves according to the interaction between these factors. Approximately 200 children living in poverty and in dysfunctional family environments, some of whose parents were subject to chemical dependency or serious mental disorders were followed up as part of the study. At age 10, two out of three children were found to have learning or behavioral problems. At age 18, more than half had mental health problems, a history of delinquency, or teenage pregnancy. However, at age 32, only about 18% of the sample had a criminal history or chronic mental health problems, and most exhibited a more adapted trajectory, being able to maintain healthy relationships with peers, satisfactory marriages, and stable jobs. This change to a more adapted and functional life path can be explained by the presence of protective factors, such as continuous education, the acquisition of vocational skills, religiosity, bonding with peers, and community participation (Werner, 1993). Figure 2 summarizes the life trajectory presented by the participants of this study and illustrates how resilience can evolve.

Life Trajectory

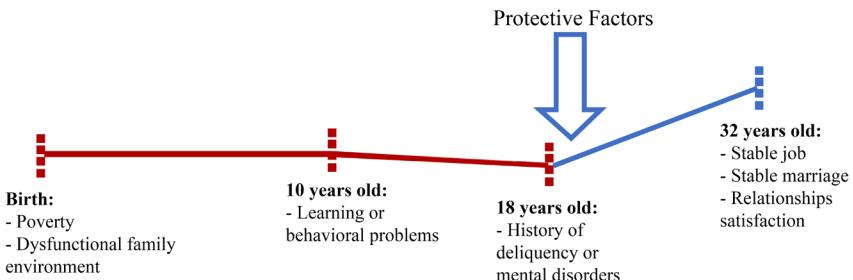


Figure 2. Illustration of the participants' life trajectories, Werner et al. (1993).

Childhood, and especially adolescence, are phases of development that are conducive to the implementation of these resilience promotion strategies (Masten & Barnes, 2018). Childhood is characterized by great cerebral plasticity, which can favor and facilitate the learning of the skills taught in resilience promotion programs. Adolescence is characterized by rapid brain development and consequent acquisition of important executive functions, such as planning and self-regulation skills. In addition, this phase is also characterized by a tendency to associate with peers who can act as role models and favor the establishment of good-quality interpersonal relationships. Thus, in adolescence, there is a confluence of biological and environmental factors that represent a window of opportunity for a more adaptive direction in life trajectory (Masten & Barnes, 2018). The development of resilience in children and adolescents is especially important, since negative experiences during this period of life tend to be associated with impaired psychological functioning in the future, leading to the emergence of emotional and behavioral problems, such as depression, anxiety and conduct disorders (Harmelen, Kievit, Ioannidis, Neufeld, Jones, Bullmore, Dolan, Finagy, & Goodyer, 2017; Traub & Boynton-Jarrett, 2017).

RESILIENCE PROGRAMS AND THEIR FEATURES

As resilience gains in popularity as an area of research, some resilience programs have been developed with a variety of features in recent years (Helmreich, Kunzler, Chmitorz, König, Binder, Wessa and Lieb, 2017). These may be designed for clinical or non-clinical populations, may present an individual or group format, be implemented face-to-face or remotely, have different theoretical approaches, and different numbers of sessions (Helmreich, Kunzler, Chmitorz, König, Binder, Wessa and Lieb, 2017). In general, most programs tend to be implemented face-to-face, as these seem to yield better results than distance interventions because they provide a more direct contact with program leaders and other participants, which also increases adherence to the program. Interventions carried out individually may provide more personalized assistance and may be tailored according to the demands of each participant, which facilitates feedback, while group interventions may be better for learning social skills, because the participants are encouraged to collaborate with others during the program (Helmreich et al., 2017). Cognitive-behavioral therapies, mindfulness-based therapies, acceptance and commitment therapies, and problem-solving therapies are some of the main approaches used in resilience programs and on which program procedures and activities are based. Most programs, however, adopt a psychoeducational approach to the concept of resilience and use methods such as discussions, practical exercises, role plays, and homework to reinforce skills learned (Helmreich et al., 2017). In addition to the more traditional psychotherapeutic procedures, some

interventions also include other types of activities, such as meditation, yoga, and even physical exercises (Laird et al., 2019).

While some programs have 15-minute sessions, others can take up to 120 minutes. Some interventions can be short, lasting 5 weeks, while others can last up to 32 weeks. The average duration of the sessions is usually around 65 minutes, lasting 14 weeks (Dray, Bowman, Campbell, Freund, Wolfenden, Hodder, McElwaine, Tremain, Bartlem, Bailey, Small, Palazzi, Oldmeadow, & Wiggers, 2017). Thus, it is clear that these programs tend to adopt a traditional therapy format according to the duration of the intervention (Joyce, Shand, Tighe, Laurente, Bryant, & Harvey, 2018).

EFFECTIVENESS OF RESILIENCE PROGRAMS

Due to the diversity of program features, a number of review studies have been carried out to assess the effectiveness of the programs in children and adolescents (Baños, Etchemendy, Mira, Riva, Gaggioli, & Botella, 2017; Dray et al., 2017; Fenwick-Smith, Dahlberg, & Thompson, 2018; Hodder, Freund, Wolfenden, Bowman, Nepal, Dray, Kingsland, Yoong, & Wiggers, 2017).

Baños et al. (2017) conducted a narrative review of positive psychology-based programs for adolescents using technology. Nine randomized controlled trials were selected, and seven different programs were identified. All of these used websites to implement the programs. Although each study analyzed different program results, all the authors reported some form of positive outcomes, such as decreased anxiety and depres-

sive symptoms, and increased psychological well-being (Baños et al., 2017).

Dray et al.'s (2017) systematic review sought to examine the effect of universal resilience programs implemented in a school setting among children and adolescents aged 5–18 years on mental health problems. These mental health problems involved both internalizing problems, such as psychological distress, anxiety, and depression, as well as externalizing problems, such as hyperactivity and conduct problems. Of the 57 randomized controlled trials (published between 1995 and 2015) included in this review, 49 provided sufficient data for a meta-analysis. The main results indicate that the programs were effective in reducing anxiety symptoms in children up to 12 years of age, while in adolescents aged 12–18 years, these programs helped reduce internalizing problems. In addition, the programs appear to be effective for depressive and anxious symptoms in the short term, that is, until 12 months after the program implementation. In the long term, that is, for a period longer than 12 months, the programs are more effective for internalizing problems (Dray et al., 2017).

Fenwick-Smith, Dahlberg, and Thompson (2018) carried out another review that also analyzed universal resilience programs implemented in primary schools in children aged between 5 and 12 years. Eleven papers published since 2002 were selected, and seven different programs identified. Ten of the 11 papers reported improvements in resilience and other factors, such as coping skills, internalizing behaviors, and self-efficacy. The authors emphasized that the involvement of teachers in the

implementation of universal programs, and the intensity and content of the sessions were key in ensuring their effectiveness (Fenwick-Smith, Dahlberg, & Thompson, 2018).

Hodder et al. (2017) sought to specifically assess the effect of universal resilience programs implemented in schools among adolescents between the ages of 10 and 18 years on reducing the use of tobacco, alcohol, or illicit drugs. Nineteen clinical trials published between 1994 and 2015 were included. The outcomes reported were tobacco use (15 studies), alcohol consumption (17 studies), and the use of illegal substances (11 studies). Only 13 clinical trials, however, provided sufficient data for a meta-analysis. The main result was the effectiveness of resilience programs in significantly reducing the use of illicit substances. However, there were no significant results for the other outcomes assessed (Hodder et al., 2017).

A RESILIENCE PROGRAM FOR ADOLESCENTS

Based on the data reported in several studies on the features of resilience programs, a resilience program for adolescents was developed by the authors. In addition to being based on the literature, the program developed by the authors was also evaluated by different experts in the fields of psychological development, interventions, and resilience in order to ensure the adequacy of the components, objectives, and the activities included in the program. The experts' suggestions were subjected to agreement analyses and these were taken into account in the final version.

The program was developed to be implemented in groups in school settings, and consists of a total of 15 sessions, each lasting 45 minutes. Program components include self-efficacy and active coping, social support and communication skills, cognitive flexibility, and optimism. These components and the activities of each component were selected because of their high association with resilience (Helmreich et al., 2017).

Activities designed to develop self-efficacy involve the identification and awareness of positive personal characteristics that are important to face challenges. These activities also involve the identification of past situations in which the participants used their personal positive characteristics to deal with problems and achieved a successful outcome. To promote an active coping style, activities that favor the development of planning and problem-solving skills through the creation and selection of effective ideas for solving problem situations were included in the program. Activities with a social support focus involve reflecting about which individuals compose the current social network of the participant and the importance of this social network in facing challenging moments. Given that proper communication is essential for the creation and maintenance of good interpersonal relationships, the DEAL technique that teaches assertive communication skills is also presented, and role playing is used to train participants in this technique: participants are encouraged to (D) describe a situation objectively, (E) express how the situation makes them feel without blaming the other person, (A) ask for a specific change, and (L) list the benefits of that change. To develop cognitive flexibility, that is, the ability to reevaluate the interpretation of

situations, the ABC model has been included. This model addresses the relationship between the occurrence of (A) adverse events, which lead to the emergence of (B) beliefs and dysfunctional thoughts and (C) consequences and negative feelings. Activities that help challenge dysfunctional beliefs through exercises in which participants must select a belief and, based on real data, seek evidence to determine whether the belief was true or false are also covered. If the beliefs are true, participants are encouraged to reflect on what could be done and what behaviors they should adopt to address or minimize its consequences. Finally, the difference between pessimism, and unrealistic and realistic optimism was addressed. The importance of a realistically optimistic viewpoint in dealing with daily difficulties and challenges is also highlighted. In addition to the adoption of a positive attitude, activities in which participants are encouraged to identify positive aspects in their lives, despite difficulties are also covered by the program.

The program therefore has a psychoeducational structure, in which the component addressed in each session is first introduced and the underlying concept explained. How the component relates to resilience, its importance, and how associated skills can be applied daily are then discussed. All components are illustrated with the help of typical examples from adolescent lives, which facilitates the understanding and application of the skills learned (Gillham, Brunwasser, & Freres, 2008). Examples are provided from the typical situations of adolescence, involving family and school issues, such as relationship problems with parents, siblings, friends, teachers, and failure at school (Polleto, Koller, & Dell'aglio,

2009). After presenting and discussing each session component, specific activities for skills training are proposed. Finally, the session is closed following an exchange of views about the activities among the participants, so they can learn from each other's experiences. At the end of each component, homework tasks to consolidate the skills learned and promote their generalization to other environments are set.

Table 1 summarizes the program structure, sessions, components, objectives, activities, and homework set.

Table 1. Resilience Program Structure.

Ses-sion	Component	Objective	Activities	Homework
1	Resilience	Program presentation	Group discussion	-
2	Self-efficacy	Introducing the concept of self-efficacy, i.e., the ability to deal with problems/challenges	Listing positive personal characteristics that help deal with problems/challenges	Listing events that the participants believe they dealt with well and their outcomes
3	Self-efficacy and active coping	Introducing the concept of active coping, i.e., having an active attitude when faced with challenging situations	Identifying a personal example of active coping	-
4	Active coping	Developing active coping through planning skills	Creating and selecting solutions for problem situations	Identifying a challenge, listing possible solutions and selecting the most viable ones
5	Active coping and social support	Introducing the concept of active coping and social support and reflect about its importance	Listing people who comprise the social support network of each participant and determine how this social support may be beneficial	-

6	Social support and communication	Reflecting how adequate communication may help the creation and maintenance of good interpersonal relations	Introduce the DEAL technique	-
7	Communication	Developing assertive communication	Exercising the DEAL technique	-
8	Communication	Developing assertive communication	Role playing	Describing a situation in which the DEAL technique was used
9	Communication and cognitive flexibility	Introducing the concept of cognitive flexibility, i.e., the ability to re-evaluate the interpretation of situations) and understanding the relationship between (A) adverse events, (B) beliefs and thoughts, and (C) consequences and feelings	Presentation of ABC model (Adverse events → Beliefs and thoughts → Consequences and feelings)	-
10	Cognitive flexibility	Understanding the relationship between (A) adverse events, (B) beliefs and thoughts, and (C) consequences and feelings	Creating an example with the ABC model (Adverse events → Beliefs and thoughts → Consequences and feelings)	Identifying and analyzing a situation according to the ABC model
1	Cognitive flexibility	Developing the ability to reinterpret situations	Challenging beliefs and automatic thoughts	Challenging an automatic thought
12	Cognitive flexibility and optimism	Introducing the concept and importance of optimism (positive perspective) and understanding the difference between pessimism and unrealistic and realistic optimism	Identifying an objective situation and interpreting it according to a pessimistic, optimistic, an unrealistic and a realistic perspective	-
13	Optimism	Having a realistically optimistic viewpoint	Identifying a realistically optimistic viewpoint for at least 2 situations	Adopting a realistically optimistic viewpoint regarding a personal situation

14	Optimism	Incorporating a realistically optimistic viewpoint by identifying the positive aspects of one's life	Listing positive aspects	List positive events each day until the next session
15	Program components	Concluding the program	Group discussion; participants asked to write about what contributed the most to resilience promotion	-

THE IMPORTANCE OF THE SCHOOL SETTING AND FUTURE DIRECTIONS IN PROMOTING RESILIENCE

Resilience-promoting strategies, such as intervention programs for children and adolescents, have yielded promising results, not only in promoting the individual's capacity for resilience, but also in promoting secondary outcomes, such as reducing depressive symptoms, substance use, and increasing psychological well-being (Baños et al., 2017; Dray et al., 2017; Hodder et al., 2017). A possible explanation for the positive outcomes may be the fact that when individuals become more resilient, they also become more prepared to deal effectively with and persevere in the face of challenges and difficulties. Thus, resilience programs that promote active coping skills, optimism and positive emotions, self-efficacy and self-esteem, cognitive flexibility, social support, healthy lifestyles, and the meaningfulness of life contribute to the reduction of a negative view of oneself and the world, passive coping styles, non-emission of important behaviors, social isolation, a sedentary lifestyle, and loss of meaning, all of which would favor negative results, such as the emergence of depression (Helmreich et al., 2017; Laird et al., 2019).

It should be noted that the school environment might give rise to greater adaptation or maladjustment in children and adolescents, depending on the nature of the interpersonal relationships established and the habits developed in that environment. Thus, if negligent or abusive relationships are established, the school setting becomes a risk factor that hinders development and adaptive functioning of children and adolescents. On the other hand, if activities that stimulate potentialities, and promote cooperation and social support are encouraged, the school environment may be a protective factor that favors greater adaptation and resilience processes (Poletto & Koller, 2008). The school may also be considered a key environment for the implementation of these resilience programs, since the execution of these strategies in the classroom ensures that these reach a greater number of children and adolescents than if these were implemented individually. Thus, early, and preventive interventions that seek to develop resilience in young people may improve levels of health and well-being in the short and long term, as these individuals would be more prepared to deal effectively with daily challenges.

These benefits may also represent an important reduction in future health care expenses, as these preventive interventions reduce the risk of developing mental disorders that are often disabling, improve people's quality of life and may even increase productivity levels, since the individual's capacity for normal functioning is more likely to be preserved. In fact, the greater the resilience, the greater the chances of perseveration and recovery in the face of adverse situations (Laird et al., 2019; Traub & Boynton- Jarrett, 2017).

Thus, investing in resilience programs for young people brings in benefits not only for the individual, but also for the entire society because these lead to benefits in the educational, public health and financial spheres in the short, medium and long terms, insofar as these individuals, having an improved quality of life and adaptive functionality, would be less likely to drop out of school or develop emotional and behavioral problems. In other words, they would be better able to respond effectively to demands that arise in their lives.

REFERENCES

- Baños, R. M., Etchemendy, E., Mira, A., Riva, G., Gaggioli, A., & Botella, C. (2017). Online Positive Interventions to Promote Well-being and Resilience in the Adolescent Population: A Narrative Review. *Frontiers in Psychiatry*, 8. doi: 10.3389/fpsyg.2017.00010
- Dray, J., Bowman, J., Campbell, E., Freund, M., Wolfenden, L., Hodder, R. K., McElwaine, K., Tremain, D., Bartlem, K., Bailey, J., Small, T., Palazzi, K., Oldmeadow, C., & Wiggers, J. (2017). Systematic Review of Universal Resilience-Focused Interventions Targeting Child and Adolescent Mental Health in the School Setting. *Journal of the American Academy of Child & Adolescent Psychiatry*, 56(10), 813–824. doi: 10.1016/j.jaac.2017.07.780
- Gillham, J. E., Brunwasser, S. M., & Freres, D. R. (2008). Preventing depression in early adolescence: The Penn Resiliency Program. In J. R. Z. Abela; B. L. Hankin. (Eds.). *Handbook of depression in children and adolescents* (309-322). New York, NY, US: The Guilford Press.
- Harmelen, A., Kievit, R., Ioannidis, K., Neufeld, S., Jones, P., Bullmore, E., Dolan, R., Finaghy, P., & Goodyer, I. (2017). Adolescent friendships predict later resilient functioning across psychosocial domains in a healthy community cohort. *Psychological Medicine*, 47(13), 2312-2322. doi: 10.1017/S0033291717000836
- Helmreich, I., Kunzler, A., Chmitorz, A., König, J., Binder, H., Wessa, M., & Lieb, K. (2017). Psychological interventions for resilience enhancement in adults.

Cochrane Database of Systematic Reviews, Issue 2. Art. No.: CD012527. doi: 10.1002/14651858.CD012527

Hodder, R. K., Freund, M., Wolfenden, L., Bowman, J., Nepal, S., Dray, J., Kingsland, M., Yoong, S. L., & Wiggers, J. (2017). Systematic review of universal school-based ‘resilience’ interventions targeting adolescent tobacco, alcohol or illicit substance use: A meta-analysis. *Preventive Medicine: An International Journal Devoted to Practice and Theory*, 100, 248–268. doi: 10.1016/j.ypmed.2017.04.003

Joyce, S., Shand, F., Tighe, J., Laurent, S. J., Bryant, R. A., & Harvey, S. B. (2018). Road to resilience: a systematic review and meta-analysis of resilience training programmes and interventions. *BMJ Open*, 8(6), e017858. doi: 10.1136/bmjopen-2017-017858

Laird, K.T., Krause, B., Funes, C., & Lavretsky, H. (2019). Psychobiological factors of resilience and depression in late life. *Translational Psychiatry*, 9, 88. doi: 10.1038/s41398-019-0424-7

Masten, A. S. (2018). Resilience Theory and Research on Children and Families: Past, Present, and Promise. *Journal of Family Theory & Review*, 10(1), 12–31. doi: 10.1111/jftr.12255

Masten, A. S., & Barnes, A. J. (2018). Resilience in Children: Developmental Perspectives. *Children*, 5(7), 98. doi: 10.3390/children5070098

Palmiter, D., Alvord, M. Dorlen, R., Comas-Diaz, L., Luthar, S. S., Maddi, S. R., O'Neill, H. K., Saakvitne, K. W., & Tedeschi, R. G. (2020). Building your resilience. Acesso em 03 mai 2020, <https://www.apa.org/topics/resilience>

Poletto, M., & Koller, S. H. (2008). Contextos Ecológicos: Promotores de Resiliência, Fatores de Risco e de Proteção (Ecological Contexts: Promoters of Resilience, Risk and Protection Factors). *Estudos de Psicologia*, 25(3), 405-416. doi: 10.1590/S0103-166X2008000300009

Polletto, M., Koller, S., & Dell'aglio, D. (2009). Eventos estressores em crianças e adolescentes em situação de vulnerabilidade social de Porto Alegre (Stressful events in children and adolescents in socially vulnerable situations in Porto Alegre). *Ciência & Saúde Coletiva*, 14(2), 455-466. doi: 10.1590/S1413-81232009000200014

Traub, F., & Boynton-Jarrett, R. (2017). Modifiable Resilience Factors to Childhood Adversity for Clinical Pediatric Practice. *Pediatrics*, 139(5), 1-16. doi: 10.1542/peds.2016-2569

Werner, E. E. (1993). Risk, resilience, and recovery: Perspectives from the Kauai Longitudinal Study. *Development and Psychopathology*, 5(4), 503–515. doi: 10.1017/S095457940000612X

CONTRIBUTING AUTHORS

AMANDA DOUAT CARDOSO

Psychologist (Mackenzie Presbyterian University), Master's student in the Postgraduate Program in Developmental Disorders (Mackenzie Presbyterian University), with a grant from the São Paulo Foundation for Research Support (FAPESP). Researcher at the Cognitive and Social Neuroscience Laboratory.

ALESSANDRA GOTUZO SEABRA

Psychologist, with Master's, Doctorate and Post-Doctorate in Experimental Psychology (University of São Paulo). Professor and coordinator of the Graduate Program in Developmental Disorders at Mackenzie Presbyterian University. Research Productivity Scholarship - CNPq. Associate editor of the journal Psicologia: Teoria e Prática and coordinator of the Child Neuropsychology Group. Vice-president of the Brazilian Institute of Neuropsychology and Behavior (IBNeC) and member of the Deliberative Council of the Brazilian Institute of Psychological Assessment (IBAP). Member of the Science for Education Network (CpE).

ALICE BATISTUZZO

Bachelor of Biological Sciences, Master and a Doctoral Student in Developmental Disorders (Mackenzie Presbyterian University), with CAPES scholarship. She has experience in the area of Ethology and Physiology, with emphasis on Neuroscience, Down Syndrome, Thyroid Hormone and Environmental Enrichment.

ANA GRASIELLE DIONÍSIO CORRÊA

Computer Engineer, Master and PhD in Electrical Engineering (University of São Paulo). PhD Professor at the Faculty of Computing and Informatics and Collaborator of the Postgraduate Program in Developmental Disorders at Mackenzie Presbyterian University.

ANA LUIZA NAVAS

Speech therapist. Ph.D. and Master in Psychology, University of Connecticut (UCONN), USA. Post-doctorate in Linguistics, State University of Campinas (UNICAMP). Associate Professor of the Speech Therapy Course at the Faculty of Medical Sciences of Santa Casa de São Paulo (FCMSCSP). Chief Editor of the journal CoDAS. Assistant coordinator of CAPES area 21 professional programs.

ANA PAULA DOS SANTOS

Educator (Universidade Estadual Paulista), specialization in Higher Education Teaching (Universidade Nove de Julho). She works at the Education Secretary of Embu das Arte, having been an effective teacher for 18 years. Since 2013 she has been an Educational and Administrative Advisor. Ana has collaborated in the integration of the Mackenzie Presbyterian University Partnership with the Embu das Artes City Hall.

BRUNA PASCARELLI PEDRICO DO NASCIMENTO

Graduated (Bachelor and Licensure) in Biological Sciences (Mackenzie Presbyterian University). Master of Science and PhD student in the Postgraduate Program in Translational Medicine at the Federal University of São Paulo.

CAMILO ERNESTO SUBENKO OLALLA

Philosopher, Psychologist, Master and PhD student in Neuroscience and Cognition (Center for Mathematics, Computing and Cognition - Federal University of ABC).

CHRISTINE ASHBY

Associate Professor of Inclusive Special Education and Disability Studies at Syracuse University. A former inclusive special education teacher, she teaches across all levels, from undergraduate to doctoral, and coordinates the undergraduate Inclusive Elementary and Special Education program and Inclusive Special Education Master's Programs. She also directs the Center on Disability and Inclusion.

CRISTIANE SILVESTRE DE PAULA

Master (2001) and Doctor (2005) in the Department of Psychiatry at the Federal University of São Paulo; Post-Doctorate work from the National School of Public Health at FIOCRUZ, RJ; Visiting Researcher at the London School of Economics in London, United Kingdom. Adjunct Professor in the Postgraduate Program in Developmental Disorders at Mackenzie Presbyterian University; Coordinator of research at the Ambulatory TEAMM/UNIFESP (since 2005).

DANIELA BORDINI

Child and Adolescent Psychiatrist from UNIFESP. Master and now a Doctoral student in Psychiatry and Psychology at UNIFESP focusing in autism. Coordinator of the Social Cognition Outpatient Ambulatory Professor Marcos Tomanik Mercadante - TEAMM / UNIFESP since 2011.

DECIO BRUNONI

Geneticist Doctor. Master, Doctorate and Lecturer in Human and Medical Genetics. Full Professor of the Postgraduate Program in Developmental Disorders at Mackenzie Presbyterian University. Researcher at the TEA-MACK Laboratory at Mackenzie Presbyterian University, São Paulo.

DENISE LEMES FERNANDES NEVES

Technologist in Data Processing, specialist in "Software Development and Management", master in Intelligence Technologies and Digital Design - PUC and doctoral student in Developmental Disorders - Mackenzie Presbyterian University. She is currently a permanent university professor at the Faculty of Technology of the South Zone - SP (FATEC).

ELISA MACEDO DEKANEY

Master's in music performance of chorus conducting (University of Missouri-Kansas City) and Ph.D. in musical education (Florida State University). Professor of undergraduate program at Syracuse University, where she is also Assistant Dean of Graduate School, Research and Interculturalization of the College of Visual and Performing Arts. Researcher with publications in several journals and conductor in several chorus festivals in the USA, Brazil and other countries.

ELIZEU COUTINHO DE MACEDO

Psychologist, Master and Doctor in Experimental Psychology (University of São Paulo). Adjunct Professor of the Postgraduate Program in Developmental Disorders at Mackenzie Presbyterian University. Member of the São Paulo Academy of Psychology (chair 32). Research Productivity Scholarship 2 - CNPq. Researcher at the Cognitive and Social Neuroscience Laboratory.

EVANISA HELENA MAIO DE BRUM

Psychologist from the Pontifical Catholic University of Rio Grande do Sul (1997), training in Psychoanalytic Psychotherapy from the Institute of Integrated Therapies of Porto Alegre (2000), Specialization in Public Health - Epidemiology from the Lutheran University of Brazil (2002) and Master in Public Mental Health by the same University (2004); Improvement in Baby Psychopathology by the Leo Kanner Institute and Paris Nord University (2005), Doctorate (2010) and Post-Doctorate (2015) in Psychology by the Federal University of Rio Grande do Sul - UFRGS. Currently a Full Professor at Cesmac acting as Coordinator of the Psychology undergraduate course, in the Master of Health Research and in the Interinstitutional Doctorate on Developmental Disorders in partnership with Mackenzie.

FERNANDA BERALDO LORENA

Bachelor and Degree in Biological Sciences (Mackenzie Presbyterian University), Master of Science and doctoral student in the Translational Medicine Program (Federal University of São Paulo). Teaches in public basic education and participates as a volunteer researcher in the research group registered with CNPQ, focused on studies and research on the biological-cultural perspective in the teaching of Sciences and Biology.

FERNANDA TEBEXRENI ORSATI

Psychologist, PhD in Special and Inclusive Education from Syracuse University. Works as a clinical psychologist, consultant in psychoeducational and inclusive supports, and she is an entrepreneur. Recently launched an alternative communication application, is a professor in the Graduate School of Psychopedagogy and is post-doctoral student in Developmental Disorders, both at Mackenzie Presbyterian University.

GRACIELLE RODRIGUES DA CUNHA

Undergraduate work in medicine at Federal University of the Triângulo Mineiro UFTM) (2001 - 2007). Medical residency in Psychiatry at the State Institute for Assistance to the Public Worker (Portuguese acronym IAMSPE) (2009 - 2011). Medical residency in Child and Adolescent Psychiatry at Federal University of São Paulo (UNIFESP). Masters in Psychiatry and Psychology at UNIFESP.

IANA SOUZA CONCÍLIO

Undergraduate work at PUC-GO, masters at UFSCar in Computing Science and Ph.D. in Electrical Engineering at Poli-USP. Instructor and mentor at Apple Developer Academy | Mackenzie 2013-2017 and Eldorado Research Institute since 2018, professor at IDEA9, FIAP e Impacta College. Twenty years of experience in higher education and mentoring in development of applications for the Apple platform.

JOAQUIM PESSOA FILHO

Graduated in Computer Science from Mackenzie Presbyterian University (2005), master's in electrical engineering from Mackenzie Presbyterian University (2007) and Doctoral student in Electrical engineering and Computing Sciences at Mackenzie Presbyterian University. Professor at the College of Informational Technology and Computing at Mackenzie Presbyterian University. Thirteen years of experience in higher education and mentoring in development of applications for the Apple platform.

JOSÉ SALOMÃO SCHWARTZMAN

Physician, childhood and adolescence neurologist. PhD in Clinical Neurology at Escola Paulista de Medicina (UNIFESP). Full Professor of the Postgraduate Program in Developmental Disorders at Mackenzie Presbyterian University. Coordinator of the Tea-Mack laboratory.

JULIANA MIDORI SATO

Graduated (Bachelor and Licensure) in Biological Sciences (Mackenzie Presbyterian University). Master of Science student in Translational Medicine at the Federal University of São Paulo.

KATERINA LUKASOVA

Psychologist, Master in Developmental Disorders and PhD in Science from the Faculty of Medicine of the University of São Paulo (FMUSP). Adjunct Professor of the Bachelor of Neuroscience at the Federal University of ABC (UFABC).

LARISSA DE MEDEIROS BOTECCHIA

Graduated in Speech Therapist from University of São Paulo (USP) and Master's student in Human Communication Health (Faculty of Medical Sciences of Santa Casa de São Paulo).

LUIZ RENATO RODRIGUES CARREIRO

Psychologist, Specialist in Neurobiology (Universidade Federal Fluminense), Master and Doctor of Science - Human Physiology (University of São Paulo). Adjunct Professor of the Psychology Course and the Postgraduate Program in Developmental Disorders at Mackenzie Presbyterian University. Associate editor and Psychological Assessment section of the journal "Psicologia: Teoria e Prática". CNPq Research Productivity Scholarship - Level 1D.

MARIA CRISTINA TRIGUERO VELOZ

Psychologist, graduated from University of Havana, Master from Federal University of Santa Catarina, and Ph.D. from Federal University of Santa Catarina. General Coordinator of the Stricto Sensu Graduate Program and Adjunct Professor of the Graduate Program in Developmental Disorders at Mackenzie Presbyterian University.

MARIA TERESA CARTHERY-GOULART

Graduated in Speech Therapy from the College of Medicine at the University of São Paulo, master's degree in Psychology (Neuroscience and Behavior) from the Institute of Psychology at the University of São Paulo and a Ph.D. in Science (Neurology) from the College of Medicine at the University of São Paulo. She is currently an Adjunct Professor at the Federal University of ABC (UFABC) and a collaborative researcher at the Cognitive and Behavioral Neurology Group - HCFMUSP.

MARINA MONZANI DA ROCHA

Psychologist and Ph.D. in Clinical Psychology from University of São Paulo. Assistant professor of the Graduate Program in Developmental Disorders at Mackenzie Presbyterian University.

MARLLOS EDUARDO DA SILVA BRANDÃO

Graduated in Biological Sciences at Mackenzie Presbyterian University (2016), master's in sciences at the Postgraduate Program in Translational Medicine at the Federal University of São Paulo (2018), he is pursuing a doctorate in Sciences at UNIFESP. Assistant Professor at the Faculty of Health Sciences IGESP and at the University Center of the Americas - FAM. Collaborating researcher at the Cardiovascular and Renal Metabolic Physiopharmacology Laboratory and at the Neurobiology and Energy Metabolism Laboratory at Mackenzie Presbyterian University.

MIRIAM OLIVEIRA RIBEIRO

Biologist (Mackenzie Presbyterian University), Master and PhD in Sciences - Human Physiology (University of São Paulo). Adjunct Professor at Mackenzie Presbyterian University. Research Productivity Scholarship 2.

NAÍMI MOREIRA NOBRE LEITE

Student of the Bachelor of Science and Technology and the Bachelor of Neuroscience at the Federal University of ABC. Currently research and acquisition of reading and writing skills in children with typical development, with analysis of fNIRS and eye-tracker.

NATHALIA RIBEIRO DE BRITO

Graduated in Speech Therapist from Faculty of Medical Sciences of Santa Casa de São Paulo (FCMSCSP) and Master's student in Human Communication Health (Faculty of Medical Sciences of Santa Casa de São Paulo).

PATRÍCIA BOTELHO DA SILVA

Psychologist, Master and PhD at Mackenzie Presbyterian University. Cotutela and double degree with the University of Luxembourg. Researcher at the Cognitive and Social Neuroscience Laboratory and Professor of the Postgraduate Course in Psychopedagogy at Mackenzie Presbyterian University. Author of TENA – Teste de Nomeação Automática, Automatic Naming Test.

PAULA RACCA SEGAMARCHI

Psychologist, Neuropsychologist specialized in Neuropsychological Rehabilitation (Clinical Hospital – University of São Paulo), Master and Doctoral Student in the Graduate Program in Developmental Disorders at Mackenzie Presbyterian University.

PEDRO BRAGA

Undergraduate and masters at the Federal University of Uberlândia in Electrical Engineering with certificate in Computing Engineering and Ph.D. Electrical Engineering e Computing at Mackenzie Presbyterian University. Mentor and Pedagogical Coordinator at Apple Developer Academy | Mackenzie since 2017, professor at the College of Informational Technology and Computing at Mackenzie Presbyterian University. Seven years of experience in higher education and mentoring in development of applications for the Apple platform.

RENATA SAMPAIO RODRIGUES SOUTINHO

Physiotherapist, master's in Health Research at Cesmac University Center. PhD student in Developmental Disorders at Mackenzie Presbyterian University (UPM). Professor of the Physiotherapy Course at Cesmac University Center. She has a specialization in the area of Women's Health and Health Management, working on themes and research in the area of voiding and coloproctological disorders.

ROSANE LOWENTHAL

Assistant Professor at the Department of Mental Health at and linked to the postgraduate program (master's and academic doctorate) in Health Sciences and Health of Human Communication (academic master's) at the Faculty of Medical Sciences of Santa Casa de São Paulo. Coordinator of the Reference Unit in Autistic Spectrum Disorders Dr Marcos T Mercadante. Post doctorate in Psychiatry and Medical Psychology at the Federal University of São Paulo - UNIFESP (2013), master's degree (2006) and doctorate (2012) in Developmental Disorders at Mackenzie Presbyterian University and undergraduate degree in Dentistry at the University of São Paulo (1988).

SILVANA MARIA BLASCOVI-ASSIS

Physiotherapist, Master and PhD in Physical Education from UNICAMP, Professor of the Physiotherapy Course and the Postgraduate Program in Developmental Disorders at Mackenzie Presbyterian University. She is currently the coordinator of the Interinstitutional Doctorate on Development Disorders in partnership with Cesmac at the promoting institution. Is interested in research with an emphasis on the following themes: Motor Development: evaluation and intervention, Social Inclusion, People with Disabilities, Down Syndrome, Cerebral Palsy, Motor Dexterity and Virtual Reality.

TAÍS MOROSI LARA CAMPOS

Psychology undergraduate, intern and researcher at the Cognitive and Social Neuroscience Laboratory at Mackenzie Presbyterian University.

THAÍS TERPINS RAVACHE

Bachelor of Biological Sciences (Mackenzie Presbyterian University), master's in biotechnology (Federal University of ABC), PhD in Developmental Disorders (Mackenzie Presbyterian University), Professor at College of Osasco.

TATIANA MATHEUS PINTO

Graduated in Psychology (Mackenzie Presbyterian University), with a period at the University of Coimbra. Master's student in the Postgraduate Program in Developmental Disorders (Mackenzie Presbyterian University), with a grant from the São Paulo Foundation for Research Support (FAPESP).

TATIANA SASAKI

Graduated in Psychology at the Pontifical Catholic University of São Paulo (2006). Clinical psychologist in a private practice. Specialist in family and couple therapy in the systemic approach and in Applied Behavior Analysis (ABA) and autism.

VANDER PEREIRA DA SILVA

Graduated in psychology from the Cruzeiro do Sul University, specialized in neuropsychology by the Neuropsychological Diagnosis Center (CDN), specialization in Neuropsychological Rehabilitation by the Institute of Neurology of the Faculty of Medicine at the University of São Paulo (IN-FMUSP) and a master's degree from the psychobiology of the Federal University of São Paulo (UNIFESP).

VANESSA MADASCHI

Graduated in Occupational Therapy from the Federal University of São Carlos (1996). PhD (2017) and Master in Developmental Disorders from Mackenzie Presbyterian University (2012). Postgraduate from the University of São Paulo in Home care (2001) and specialist in physical rehabilitation from the AACD (1997). Worked as a teacher in the Occupational Therapy course at UFSCar, as an occupational therapist at Hospital Israelita Albert Einstein, at the Sarah Network of Rehabilitation Hospitals and in the children's sector of AACD. Partner-director at Inclusão Eficiente - SP.

Remissive Index

A	
Acessibility	289
Acquisition of reading	113, 117, 160, 170, 285
Adaptation	67, 69, 93, 98, 99, 138, 155, 184, 236, 237, 239, 240, 260, 273
Adolescence	213, 263, 283
App	101
Assistive technologies	96, 102
Attention deficit hyperactivity disorder	149, 167, 172, 196, 241, 207, 234
Autism spectrum disorder	34, 59, 107, 145, 146, 152, 204, 225, 227, 228, 229, 230, 232
Autonomy	76, 91, 204, 217, 219
B	
Basic education	33, 58, 59, 60, 139, 140, 141, 208, 281
Behavioral problems	91, 203, 205, 206, 209, 210, 262, 264, 274
C	
CAPES	11, 17, 27, 28, 34, 35, 51, 52, 61, 62, 63, 277
Childhood education	59, 222, 235
Clinical signs	214, 217
Cognitive functions	88, 154, 252

Cross-cultural study	60
Culturally relevant pedagogy	13, 19, 37, 38, 46, 47, 49
D	
Decision-making	103, 140, 212, 220
Digital education	65
Down syndrome	60, 106, 107, 201, 277, 286
E	
Education	8, 9, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 24, 25, 26, 27, 31, 32, 33, 34, 35, 36, 38, 39, 48, 51, 52, 56, 58, 59, 60, 62, 63, 65, 66, 67, 79, 80, 81, 82, 85, 109, 139, 140, 141, 144, 147, 173, 174, 175, 176, 179, 180, 181, 184, 188, 190, 191, 192, 195, 199, 203, 205, 208, 210, 216, 218, 219, 222, 223, 224, 234, 235, 237, 240, 280, 282, 285, 286, 294
Educational neuroscience	126
Educational practices	15, 19, 21, 31, 66, 82
Educational transformation	67
Education professionals	205, 222, 240
Educators	15, 17, 21, 37, 38, 40, 41, 65, 67, 69, 81, 91, 94, 147, 151, 182, 183, 185, 205, 222, 231

Elementary school	58, 59, 60, 74, 102, 149, 151, 152, 191, 210, 212
Engagement	66, 67, 177, 178, 179, 180, 182, 183, 184, 186, 261
Environmental factors	138, 196, 204, 221, 225, 263
Etiology	89, 92, 195, 197, 209, 211, 214
Evaluation	13, 14, 20, 53, 58, 60, 75, 109, 111, 127, 135, 136, 138, 139, 140, 141, 142, 143, 144, 145, 147, 148, 150, 161, 202, 206, 211, 215, 218, 230, 238, 286
Executive functions	117, 149, 154, 234, 263
Exposure of animals	247
F	
Family inclusion	196, 219
Flexibility	77, 268, 269, 271, 273
Fluency	13, 19, 37, 39, 41, 42, 46, 47, 114, 126, 154, 155, 156, 159, 160, 161, 163, 164, 165, 167, 169, 170, 231
fNIRS	111, 124, 125, 127, 128, 130, 132, 133, 285
G	
Genetic abnormalities	89

H	
Health	7, 8, 19, 21, 28, 32, 33, 35, 43, 54, 56, 60, 61, 88, 89, 97, 136, 138, 139, 141, 142, 143, 144, 145, 146, 148, 149, 150, 151, 184, 193, 194, 195, 196, 200, 202, 205, 206, 208, 209, 210, 211, 216, 220, 221, 224, 230, 231, 235, 262, 266, 273, 274, 279, 281, 284, 286
Health networks and programs	145, 206
I	
Inclusive education	9, 14, 21, 59, 63, 151, 173, 174, 175, 176, 178, 181, 183, 189, 173, 178, 180, 190, 192, 222, 281
Inclusive practices	176, 180
Indigenous Brazilian	39, 44
Intelligence	60, 87, 91, 108, 135, 149, 196, 209
Intelligence	78, 79, 280
Interdisciplinary	13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 27, 28, 29, 30, 31, 33, 34, 35, 37, 41, 44, 47, 48, 53, 54, 55, 56, 57, 61, 63, 76, 144, 194, 205, 206, 209, 213, 231, 236, 295
Interdisciplinary formation	57
Interdisciplinary treatments	194

Intervention	22, 34, 61, 93, 94, 109, 136, 137, 139, 142, 143, 145, 146, 167, 191, 199, 200, 206, 207, 210, 213, 215, 217, 218, 232, 238, 240, 243, 245, 247, 253, 256, 259, 265, 267, 272, 286
	J
Job market	82
	L
Language	7, 14, 21, 95, 106, 111, 115, 116, 117, 119, 120, 122, 126, 130, 131, 153, 156, 157, 166, 170, 184, 197, 208, 217, 231, 233, 235, 236, 238, 240, 241, 242, 243, 244
Language	7, 84, 111, 126, 230, 232, 234, 243
Learning	13, 14, 18, 22, 31, 38, 39, 41, 8, 20, 292
Learning from experience	67
Learning materials	97
Lexical word recognition	123
Lexicons	117
Literacy	96, 97, 101, 102, 103, 104, 105, 111, 114, 117, 119, 126, 131, 133, 153, 154, 159, 161, 191, 204, 236, 244
Logical-mathematical reasoning	103

M	
MEC	27
Methodologies	27, 65, 69, 83, 107, 137, 196, 235
Multidisciplinary team	194, 200, 238
N	
Neural activation	121, 122
Neural basic mechanisms	56
Neural signal	127
Neurobehavioral complaints	14, 20, 135, 147, 148, 294
Neurobiological basis	214
Neuroplasticity	248, 255 ,256
O	
Oral and written language	112, 119, 126, 231, 234, 238
Oral language	115, 154, 232, 233, 234, 240
P	
Pedagogy	31, 48, 49, 281, 37, 38, 46, 47, 191
Phonology	113, 115
Preventive approach	289
Prognosis	94, 195, 203, 205, 209, 210, 217
Protective factors	260, 261, 261, 262
Psychometric tests	92
Public policy	13, 20, 51, 57, 58, 60, 62, 63
Q	
Quality of life	90, 94, 249, 274
Quilombola community	60

R	
Rapid automatized naming	153, 160, 168, 169, 170, 171, 172
Reading	14, 19, 21, 111, 112, 113, 114, 115, 117, 118, 119, 126, 129, 132, 148, 153, 154, 155, 156, 157, 158, 159, 160, 162, 163, 164, 165, 166, 167, 168, 169, 170, 204, 211, 231, 234, 236, 239, 240, 241, 242, 243, 285
Reading	153, 154, 156, 159, 171, 243
Rehabilitation	146, 219, 231, 235, 238, 287, 288
Resilience	14, 22, 42, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 272, 273, 274, 275, 276
Risk factors	197, 198, 209, 227, 260
S	
School complaints	34, 203
School environment	59, 234, 273
School period	251
School program and policies	176
Self-learning	76
Social inclusion	29, 53, 56, 223, 224, 286
Social interaction	88, 218, 248
Social skills	79, 80, 81, 135, 138, 149, 152, 264
Social vulnerability	262
Specialized education	59, 60

Specific learning disorder	34, 196, 204, 232, 234, 236, 239, 243
Speech therapy	7, 14, 21, 29, 231, 232, 235, 237, 242, 284
Strategies for learning	88
SUS	145, 146, 148, 206, 294
T	
Teachers	34, 38, 39, 40, 41, 42, 46, 47, 49, 51, 52, 53, 55, 56, 57, 59, 60, 62, 63, 66, 67, 70, 75, 76, 77, 81, 82, 103, 138, 140, 141, 142, 143, 144, 147, 152, 177, 178, 179, 180, 181, 182, 183, 184, 188, 189, 190, 191, 192, 205, 210, 212, 222, 223, 233, 235, 236, 267, 270
Teacher training	19, 51, 67, 176, 188, 241
Teaching	7, 17, 18, 28, 31, 33, 34, 38, 42, 47, 49, 51, 52, 57, 61, 62, 65, 66, 67, 69, 70, 74, 80, 81, 82, 83, 84, 85, 86, 88, 97, 131, 137, 154, 174, 177, 183, 186, 188, 189, 190, 192, 231, 235, 243, 278, 281
Teaching and learning process	69, 88, 97, 231
Teaching-learning applications	96
Teaching methods	69, 85
Teaching practice	37, 38, 59, 82

Technological resources	62, 65, 98
Training	13, 17, 19, 28, 32, 51, 52, 53, 56, 57, 60, 62, 63, 67, 77, 78, 79, 80, 82, 84, 100, 101, 137, 142, 146, 147, 148, 149, 176, 182, 188, 189, 207, 222, 223, 236, 241, 242, 256, 270, 275, 281
	W
Working memory	13, 20, 101, 111, 117, 131, 132, 133, 167
Working memory	111, 121, 131
Write	111, 116, 119, 142, 233, 272