The Use of Stories to Teach Emotion Recognition via Facial Expressions Among Children With ASD

Ricardo Martinelli Bondioli[1], Miriana de Araujo Biazim[1], Priscila Benitez[2],
Camila Domeniconi[1]

[1] Universidade Federal de São Carlos, São Carlos, São Paulo – Brazil
[2] Universidade Federal do ABC, Santo André, São Paulo – Brazil

Author Note

Ricardo M. Bondioli https://orcid.org/0000-0003-4221-1351
Miriana de A. Biazim https://orcid.org/0000-0002-6835-5575
Priscila Benitez https://orcid.org/0000-0003-3501-7606
Camila Domeniconi https://orcid.org/0000-0003-0486-3543

Correspondence concerning this article should be addressed to Ricardo Martinelli Bondioli, Rua do Agronegócios, 184, Parque do Espraiado, São Carlos, SP, Brazil. CEP 13566423. E-mail: ricardo.bondioli@gmail.com

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Abstract

This study aimed to assess a procedure using social stories to teach children with ASD to identify four emotions via facial expressions: joy, surprise, anger, and sadness. Other teaching programs focused on other areas of child development (i.e., socialization, cognition, language, self-care, and motor development) were simultaneously implemented. Three families with children with ASD were selected. The children's mothers received guidance via telehealth and were responsible for implementing the programs due to the social isolation imposed during the COVID-19 Pandemic. The dependent variables were the pre- and post-tests measuring the children's performance in Operationalized Portage Inventory (OPI), the number of correct answers in the general socialization programs, the number of correct answers in the programs teaching emotion recognition, the scores concerning the interaction and engagement checklist verified in the intervention videos sent by the mothers, the scores obtained in the EVALOF (Evaluation Scale of Oral Language in Family Context), and the mothers' social validity of the procedure. The independent variable concerned the mothers' application of the teaching procedure. The results showed that children P2 and P3 improved their ability to identify emotions based on facial expressions. Qualitative improvements were verified in the mothers' ability to implement the tasks. The mothers were generally very satisfied with their participation in the intervention and their children's progress.

Keywords: emotional facial expression, autism spectrum disorder, social story, training with mothers, telehealth

USO DE HISTÓRIAS PARA ENSINO DE RECONHECIMENTO DE EXPRESSÕES FACIAIS DE EMOÇÕES PARA CRIANÇAS COM TEA

Resumo

O presente estudo teve como objetivo avaliar um procedimento de ensino utilizando histórias sociais para identificação de quatro expressões emocionais faciais por crianças com TEA: alegria, surpresa, raiva e tristeza, e, em segunda instância e de forma concomitante, a aplicação de outros programas de ensino de áreas do desenvolvimento infantil (socialização, cognição, linguagem, autocuidado e desenvolvimento motor). Foram selecionadas três famílias com filhos com TEA e, por motivos de isolamento social da pandemia da Covid-19, os programas foram aplicados pelas mães, orientadas via telessaúde. As variáveis dependentes foram: pré e pós-teste do desempenho da criança no IPO, número de acertos nos programas gerais de socialização, número de acertos nos programas específicos de identificação de faces de emoções, pontuação no *checklist* de interação e engajamento dos vídeos de intervenção enviados pelas mães, pontuação na EVALOF (Escala de Avaliação da Linguagem Oral em Contexto Familiar) e medida de validade social das mães. A variável independente envolveu a aplicação do procedimento de ensino diretamente pelas mães. Os resultados apresentaram evolução das crianças (P2 e P3) na aquisição de novas habilidades de identificação de faces de expressões emocionais. Qualitativamente, analisaram-se aprimoramentos nas habilidades das mães na aplicação das atividades, e elas, no geral, mostraram-se muito satisfeitas com a participação delas e com o progresso dos filhos.

Palavras-chave: expressão facial emocional, transtorno do espectro autista, história social, treino com mães, telessaúde

USO DE CUENTOS PARA ENSEÑAR EL RECONOCIMIENTO DE EXPRESIONES FACIALES DE EMOCIONES A NIÑOS CON TEA

Resumen

El presente estudio tuvo como objetivo evaluar un procedimiento de enseñanza utilizando historias sociales para identificar cuatro expresiones emocionales faciales en niños con TEA: alegría, sorpresa, enojo y tristeza y en segundo lugar y concomitantemente, la aplicación de otros programas de enseñanza para áreas del desarrollo infantil (socialización, cognición, lenguaje, autocuidado y desarrollo motor. Se seleccionaron tres familias con niños con TEA, y por motivos de aislamiento social durante la Pandemia Sars Covid 19, los programas fueron aplicados por las madres y orientados vía telesalud. Las variables dependientes fueron: pre. y post prueba del desempeño del niño en el IPO, número de respuestas correctas en los programas generales de socialización, número de respuestas correctas en los programas específicos de

identificación de rostros emocionales, puntuación en la lista de verificación de interacción y participación en los videos de intervención enviados por las madres, puntuación en la EVALOF (Escala de Evaluación del Lenguaje Oral en un Contexto Familiar) y medida de validez social de las madres. La variable independiente implicó la aplicación del procedimiento de enseñanza directamente por parte de las madres. Los resultados mostraron la evolución de los niños (P2 y P3) en la adquisición de nuevas habilidades en la identificación de rostros y expresiones emocionales. Cualitativamente se analizaron las mejoras en las habilidades de las madres en la implementación de las actividades y, en general, se mostraron muy satisfechas con su participación y con el progreso de sus hijos.

Palabras-clave: expresión facial emocional, trastorno del espectro autista, historia social, formación con madres, telesalud

The DSM-V defines autism as a neurodevelopmental disorder that impacts an individual's social interaction, communication skills, and behavioral patterns. It is a spectrum disorder, meaning it can manifest in different forms at varying degrees of severity (American Psychiatric Association [APA], 2014). Individuals with autism often lack interest in social interactions, find it challenging to adapt to social situations, and experience poor interpersonal communication, which is explained by the disorder's intrinsic difficulties in identifying and recognizing other people's facial expressions and affective states (Keating & Cook, 2021; Guo & Qiu, 2024).

Many studies have recently reported significant advancements in understanding the mechanisms underlying impaired facial expression recognition among children with autism through neuroimaging techniques. Results show abnormal brain activity patterns in children with autism during the processing of facial expressions (Briot et al., 2021; Meyer Lindenberg et al., 2022; Uono et al., 2022; Guo & Qiu, 2024). Such studies provide relevant information for further investigating the causes of difficulties in recognizing facial expressions and designing effective intervention teaching modalities. (Petrovska & Trajkovski, 2019; Premkumar et al., 2020; Wieckowski et al., 2020; Garcia-Garcia et al., 2021; Webster et al., 2021; Li et al., 2023; Tamas et al., 2024).

Given the importance of facial expressions in social communication, understanding the intrinsic mechanisms of impaired facial expression recognition among children with autism is particularly relevant to helping them overcome difficulties, improve social skills, and enhance their quality of life (Petrovska & Trajkovski, 2019; Premkumar et al., 2020; Wieckowski et al., 2020; Garcia-Garcia et al., 2021; Li et al., 2023; Guo & Qiu, 2024; Tamas et al., 2024).

Several recent studies have assessed teaching procedures that promote new acquisitions in the field of emotions and meet the needs of ASD regarding teaching structuring, predictability, and generalization of learned stimuli (Munoz, 2018; Petrovska & Trajkovski, 2019; Premkumar et al., 2020; Wieckowski et al., 2020; Garcia-Garcia et al., 2021; Webster et al., 2021; Li et al., 2023; Tamas et al., 2024).

Li et al. (2023) conducted a longitudinal study to monitor the development of three emotion recognition skills (i.e., discriminating and identifying facial expressions and the ability to assign emotions in certain situations) among children aged 2.5 to 6 over three years. The final research sample included 61 children with ASD and 121 neurotypical children. The tasks, presented 4 times, required minimal verbalization (given the participants' young age) and involved only four basic emotions: happiness, anger, sadness, and fear.

Their results confirmed the difficulties individuals with ASD faced since preschool to recognize emotions, especially processing emotional information based on one's facial expression. No differences were found between the groups (children with ASD and neurotypical) in the tasks in which situational clues accompanied emotional information. This finding indicates the difficulties in ASD regarding the processing of facial information. Also, according to the previous study, neurotypical children learn to recognize emotions by identifying facial features and then recognizing emotions based on situational clues. Emotion recognition is an advanced skill, and

the results showed that children with ASD learned to recognize emotions better by associating emotions with situational clues, reinforcing the inability of children with ASD to visually track facial expressions, requiring stories and characters to facilitate learning. Another aspect found was that emotions in both children with ASD and neurotypical children developed over time. The only difference found concerned the inability of children with ASD to discriminate between negative and positive facial expressions, reinforcing previous results regarding the processing of facial information.

These results corroborate the study by Munoz (2018) on the recognition of emotions among children with ASD between 4 and 14 years old. Her results showed that age was a differential for emotion recognition. At the same time, participants with ASD found it more challenging to identify emotions of negative valence, such as fear, sadness, or anger, than the neurotypical children. Another critical aspect addressed in the study above concerns visual tracking. Children with ASD were unable to keep their gaze on a face, especially eyes and mouth, for a considerable period, as they kept a diffuse look at these regions.

Visual processing of actual facial expressions combined with the interpretation of emotions is a significant challenge for people with ASD. Some studies have already shown that children with autism might find it easier to learn to recognize emotions with pictograms, drawings, and stories than with images of actual faces (Petrovska & Trajkovski, 2019; Keating & Cook, 2021; Li et al., 2023).

Petrovska and Trajkovski (2019) assessed the effects of an intervention using a computerized program to improve the knowledge of emotions (sadness, happiness, fear, and anger) among children diagnosed with ASD through photographs, pictograms, and illustrations of social contexts. Using six different games, the children were instructed to identify, discriminate, and pair different facial expressions with emotions and social contexts.

Their results were positive and showed the effectiveness of teaching emotion recognition using photographs of actual faces and pictograms and improved understanding of emotions based on situations. Their results also showed the effectiveness in generalizing the acquired skills applied to stimuli (faces and situations) previously unknown to the users, which emerged through the correspondence of facial expressions between identities. The participants performed better when pictograms were used instead of photographs of actual faces. This piece of information corroborates previous studies (Grelotti et al., 2005; Rosset et al., 2007) that showed strong evidence of the effect that pictograms and cartoons have on visual processing and discrimination in children with ASD, besides the cartoons' intrinsic motivational value among children, which favors learning new repertoires.

These results corroborate the success of interventions in which teaching tools associated with playful resources and didactic methods are adopted to teach new behavioral arrangements. Therefore, this study's objective was twofold. The first was to assess a teaching procedure using social stories to teach children with ASD to identify emotions considering four emotional facial expressions: joy, surprise, anger, and sadness. Next, other teaching programs focused on child

development (i.e., socialization, cognition, language, self-care, and motor development) were simultaneously implemented.

Note that this study was conducted during the COVID-19 Pandemic when social isolation was needed to prevent and decrease the spread of the virus. Therefore, this study was implemented in the Telehealth modality. Such a modality has effectiveness and applicability advantages and favors family involvement in the application of teaching procedures and in the development of new behavioral repertoires (Antill, 2020; Carneiro et al., 2020; Craig, Dounavi & Ferguson, 2022; Domeniconi et al., 2024).

Hence, this study is expected to contribute to the field of emotional research that involves people with ASD and to the continuity of behavioral interventions in the parent-mediated telehealth format.

Method

Participants

Table 1 characterizes the study sample: three children with ASD (P1, P2, and P3) who are enrolled in a regular school and their mothers (M1, M2, and M3).

Table 1

Sample: mother and child with ASD

Participants	Age (years)	Sex	Medication	Regular school	Mothers	Age (Years)	Mothers' schooling
P1	2	M	Homeopathy	Yes	M1	43	Bachelor's degree
P2	6	M	No	Yes	M2	39	Some undergraduate studies
P3	3	M	No	Yes	M3	37	Bachelor's degree

The criteria for including the children were being on the waiting list to receive care at a School Health Unit and having access to the Internet via mobile phone or computer to receive care remotely. The families on the list were invited to participate in the teaching intervention via the telehealth modality.

Material

The meetings were held via videoconference once a week, according to the family's availability. Guidance and feedback were provided via a messaging application.

The resources used to teach emotion recognition included social stories taken from Silva et al. (2013) in which situations related to four emotions (i.e., joy, sadness, anger, and fear) are presented. The social story about joy presents a character who dreams of having a dog. The character gets a dog on her birthday as a gift. Hence, the participant is instructed to report the character's emotion as a response to the gift. The social story of sadness is about a character who has a kite. His kite gets tangled in a tree and is torn. Hence, the child is instructed to name the

character's emotion toward the situation. The social story of anger is about two friends participating in a racing game. At the end of the game, one of the characters wins the race, but a friend grants victory to the character who failed to come in the first place. Hence, the participant is asked to choose the expression that best represents the character's emotion. Finally, the last emotion concerns fear. The book tells about a character who liked to play ball indoors, despite her mother having already asked her not to play inside the house because she could break something. The character decides to play ball indoors on a rainy day and breaks a window; thus, she knows her mother will be angry. The participant is then instructed to report which expression represents the character's emotion. The answer options included 4 facial expressions representing the characters' emotions.

The resources used in the other programs teaching deficient skills measured by the OPI were developed according to the teaching programs made available by ASSERT – Autism Support Services: Education, Research, and Training (Higbee, 2012).

The meetings were grounded on scientific principles of behavior (Skinner, 1953), with behavioral interventions aimed at teaching socially relevant behaviors and decreasing challenging repertoires (Braga-Kenyon, Kenyon & Miguel, 2005; Cooper, Heron & Heward, 1989).

Table 2 shows the teaching objectives listed in the general socialization programs of the three participants.

Table 2
Description of the teaching objectives in the general socialization programs

	P1	P2	P3
Visual Contact			
· Making eye contact when interrupted during a game	X		X
· Looking at the caregiver during the game "Where is mommy"?	X		
· Making eye contact when instructed, "Look at me"	X		
· Making eye contact when called by name	X		
Imitation			
· Imitating sounds of the vowels (A, E, I, O, U) and "dah".	X		
· Imitating the hello/bye gesture when greeting	X		
· Imitating two motor movements that the child already knows how to perform independently and a new movement the child needs to learn	X		
· Repeating rhymes and songs		X	
Following instructions			
· Waiting for five seconds		X	
· Getting an object			X
· Fetching and getting an object when asked	X		
· Holding and carrying a soft toy	X	X	
· Following two two-step instructions		X	
· Following three-step instructions		X	
· Following instructions in social situations (e.g., getting the TV remote control to watch his/her preferred cartoon)			X

Table 2

Description of the teaching objectives in the general socialization programs

	P1	P2	P3
Identification and Naming			
· Identifying and naming emotions		X	X
· Identifying situations and emotion-associated actions		X	
· Naming the fear expression		X	
· Naming emotion faces			X
Children's stories			
· Choosing a book	X		
· Listening to stories	X		
· Interacting with the mother during storytelling and asking questions		X	
· Dramatizing excerpts from stories by playing a social role or using puppets		X	
Games			
· Playing pretend with social role stimulation		X	
· Playing with rules: tic-tac-toe and hangman		X	
· Playing with rules: hide-and-seek in the role of catcher			X
· Playing with rules: memory game, dominoes, hide-and-seek	X	X	
· Playing with rules: magic bag – relating the number with the amount of pieces to be taken from the bag		X	
· Playing with rules: musical statues – dancing freely when a song is playing and then standing still when the song stops		X	
· Playing with rules involving emotions		X	
· Dramatizing an excerpt or story of any character		X	
· Playing ball in pairs – catching and throwing a ball with another child	X		
· Playing with modeling clay – squeezing and shaping	X		

The Evaluation Scale of Oral Language in Family Context (EVALOF – Balog, 2019) was applied, considering that data were collected and intervention was implemented in the family context. The scale was used to observe and record daily family interactions, considering information about the children's ages and sexes, the type of activity performed, the gender of the adult caregiver, and the number of children and adults present in the interaction.

Additionally, previous studies supported the creation of a checklist (Piccinini et al., 2001; Balog, 2019) to analyze the interaction of the mother-child pair with ASD. The checklist was applied to videos depicting the mothers' engagement during the intervention, the quality of each pair's interaction, and the children's responses during interaction in the teaching programs (Table 3).

Table 3

Checklist for analyzing the interaction of the mother–child pair with ASD

Category	Category's Description	Examples
Mother's engagement in the intervention	Whether the mother implemented the tasks suggested for the week, how frequently she implemented the tasks, whether she recorded the child's responses, whether she sent the videos, and whether she had doubts or made comments in the group.	

Quality of the pair's interaction: analysis of the mother–child interaction	· The number of oral instructions the mother provided.
	· Adequate and inadequate instructions the mother provided.
	· Whether the child smiled and kept visual contact with the mother during the interaction, whether the resources and environment were adequate to implement the intervention, whether the child attempted to communicate, and whether the mother was responsive to the child's attempts to communicate.
	· Whether the mother provided any cue when implementing the task.
	  ◦ VC –verbal cue, any oral instruction that indicated the correct answer;
	  ◦ GC – gestural cue, any movement with the body that indicates the correct answer;
	  ◦ TPC – total physical cue, providing motor support for the child to complete the task.
	· Whether the mother complimented the child immediately after providing a correct answer, whether the consequence the mother gave was adequate, whether the mother was able to manage the child's inadequate behavior during the intervention, whether the child took the initiative to seek his mother, and whether the child answered to his mother's requests.
		Adequate instructions: using few direct words to communicate what the child is expected to do, giving the child time to answer.
		Inadequate instructions: many and unnecessary words are used to explain the task, and instructions are given without the child having time to answer.
		VC: "Says: I want more" (M3 is indicating to P3 that the program is asking for more)
		GC: "Here" (M1 points the correct answer to P1)
		TPC: "M1 gets P1's hands and puts on his shorts, then pulls up the child's hand holding the shorts."
		Adequate consequences: tangible, immediate, sensorial, and social consequences (e.g., a compliment)
		Inadequate consequences: saying no after the child's response).

Child interaction response in the teaching programs and free play.	The number of correct and incorrect answers to tasks, inadequate behaviors during the intervention, and the number of communicative interactions.	

Finally, a questionnaire with five blocks of statements rated on a Likert scale ranging from 1 to 5 (completely disagree to completely agree) was applied. It assessed the mothers on the following: a) tasks intended to achieve the teaching objectives (e.g., Were the tasks helpful in promoting the child's development?); b) mother-intern interaction (e.g., Were the cues provided by the mother during the sessions valuable and constructive); c) self-monitoring (e.g., I believe that I dedicated myself to implementing the tasks); and d) the performance of the child with ASD in the tasks (e.g., I believe that my child learned skills related to socialization during this period), e) self-assessment of the interaction between mother–child with ASD ("I pay more attention to my child's needs").

The independent variable concerns telling social stories associated with emotions to measure the dependent variables: a) pre- and post-test of the child's performance; b) the number of correct answers in general socialization programs, the objectives of which were eye contact, imitation, following instructions, identification and naming, child stories, and games; c)

the number of correct answers accumulated in the program in which emotion faces were identified in the context of stories; d) scores on the checklist assessing the intervention videos to analyze the mother's engagement; e) scores obtained in the EVALOF to analyze the interaction of the mother–child pair; and f) measure of the mothers' social validity.

Procedures

This study was approved by the Institutional Review Board at UFSCar (Opinion No. 4,526,155, CAEE (26257819.7.0000.5504)). The children's mothers provided their consent through an online form following Amendment No. 1 of the previously mentioned process.

This study was divided into 5 phases: the initial interview, a pre–test assessment, the intervention, a post–test reassessment, and, finally, the application of instruments to assess the mothers' engagement.

Phase 1: The families were contacted, and a synchronous meeting was scheduled with each family to provide clarification of the study's objectives, the parents' participation in implementing the programs, and the necessary conditions for data collection, such as filming all the tasks and sending the videos to the author. At the time, a document was also provided with written instructions, and the participants filled out an online free and informed consent form.

The families were weekly instructed to a) comply with scheduled times, b) send written records, and c) send a video of each activity per week. The material sent by the mothers supported an analysis of the children's performances, and the teaching programs were updated as required (i.e., if the child already presented an independent response, the researcher would prepare a new activity with a new teaching objective).

Phase 2: Assessment of the child's behavioral repertoire: The OPI was applied in a synchronous meeting, during which the mothers were interviewed using the protocol questions. Hence, there was no direct assessment; it was only based on the mothers' reports.

Phase 3: The families implemented the activities weekly under the researcher's supervision.

The mothers were first instructed on the basic principles of behavior analysis and their applicability in interventions. They also received guidance on how to apply specific emotion tasks, i.e., they were asked to tell a story about a character and then ask the children to report the facial expression corresponding to the expected emotion in each situation. The response options included the drawings of four faces representing four emotions. If the children answered correctly, the mothers were instructed to provide positive reinforcement and were taught the importance of valuing their children's learning. If the children made a mistake, the mothers were instructed to correct the child properly and encourage new attempts.

As the mothers implemented the activities, they filmed the tasks and sent the videos via WhatsApp. Once a week, depending on the family's availability, a synchronous meeting was held for the mothers to report how they had implemented the program and receive further guidance when needed.

The mothers were also instructed on recording the children's responses and on the importance of recording how the tasks were applied.

The activities were implemented for 12 weeks, in which the mothers received an emotion questionnaire with a pre-test, intervention, and post-test phase. The Operationalized Portage Inventory – OPI (Williams & Aiello, 2001) was applied to the mothers in an interview format to assess the children's behavioral repertoire (pre-test and post-test) and characterize the skills of 0 to 6-year-old children in five areas (i.e., motor development, language, cognition, socialization, and self-care).

The study focused on socialization skills, which support new emotion identification and recognition skills in social contexts. Due to the pandemic conditions of social isolation, the families of children with ASD were also offered teaching resources aimed at other areas of development so that the children's development would benefit from learning new skills and the mothers would learn new resources to implement at home.

When the child correctly identified an emotion in 3 attempts after a social story was told, the family was suggested to add a new emotion until 4 emotions, among other tasks, were successfully completed.

Phase 4: Reassessment of the children's behavioral repertoire: The Operationalized Portage Inventory was applied a second time to the mothers to measure the gains the children obtained with the procedure.

Phase 5: Instruments were applied to assess the mothers' engagement as well as their interaction with their children during the study.

Results

The data obtained in the pre- and post-test show the participants' acquisitions. Figure 1 shows the three children's performance in the OPI before and after the teaching procedures were implemented. Note that the children were assisted by other programs focusing on the five areas of child development, but the primary objective was to implement emotion recognition resources. Hence, the socialization programs that would favor the acquisition of emotion identification skills were implemented simultaneously. Figure 1 presents the three participants' deficits and acquisitions evidenced in the pre- and post-test.

Figure 1

Results obtained by P1 (pre-test) and by P2 and P3 (pre- and post-test in OPI)
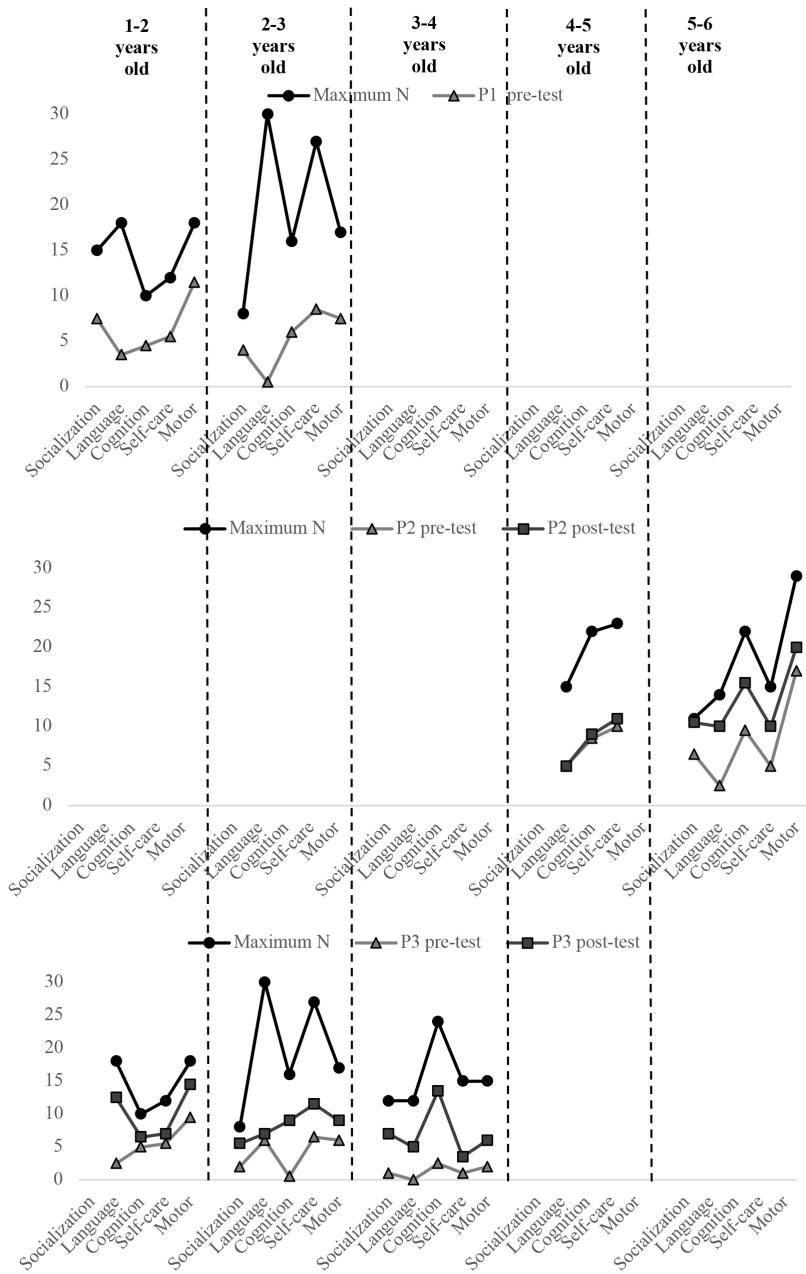
The teaching objectives established for P1 in the general socialization programs included imitation, eye contact, hand greeting, and fetching/taking an object to a person when requested.

The objectives established for P2 in the general socialization programs included repeating rhymes, following two-step instructions, and playing make-believe. No records regarding P3 in the socialization programs were provided, except for the recognition of facial expressions presented in the text. Both P1 and P2 acquired skills in the socialization programs. P1 performed better in the imitation task, fetching and taking objects to someone when requested. Similarly to P2, who performed increasingly better throughout the intervention, achieving the teaching objectives of repeating rhymes, following two-step instructions, and playing pretend.

The three participants learned at least one emotion in the interventions, which focused on emotion recognition based on social stories. P1 was given a book about joy, P2 was given a book about joy, sadness, and anger, and P3 was taught the four emotions: joy, sadness, fear, and anger.

Figure 2 shows P1's performance in the book of joy. M1 did not apply any of the other books to P1.

Figure 2

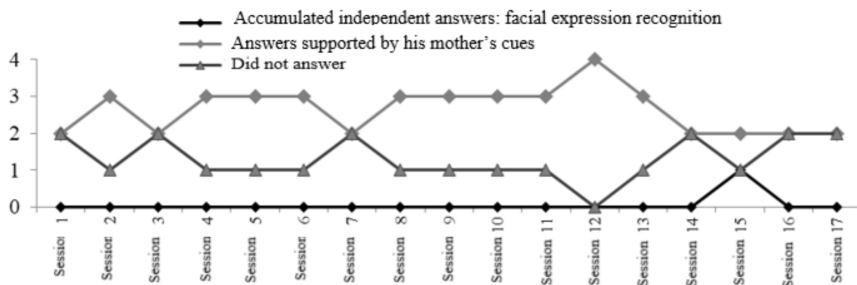*P1's performance on the book about joy, according to the session.*

Figure 3 shows P2's performance in the books about happiness, sadness, and anger. The book about fear was not used. Note that the mother recorded only one attempt per session for the book about joy.

Figure 3

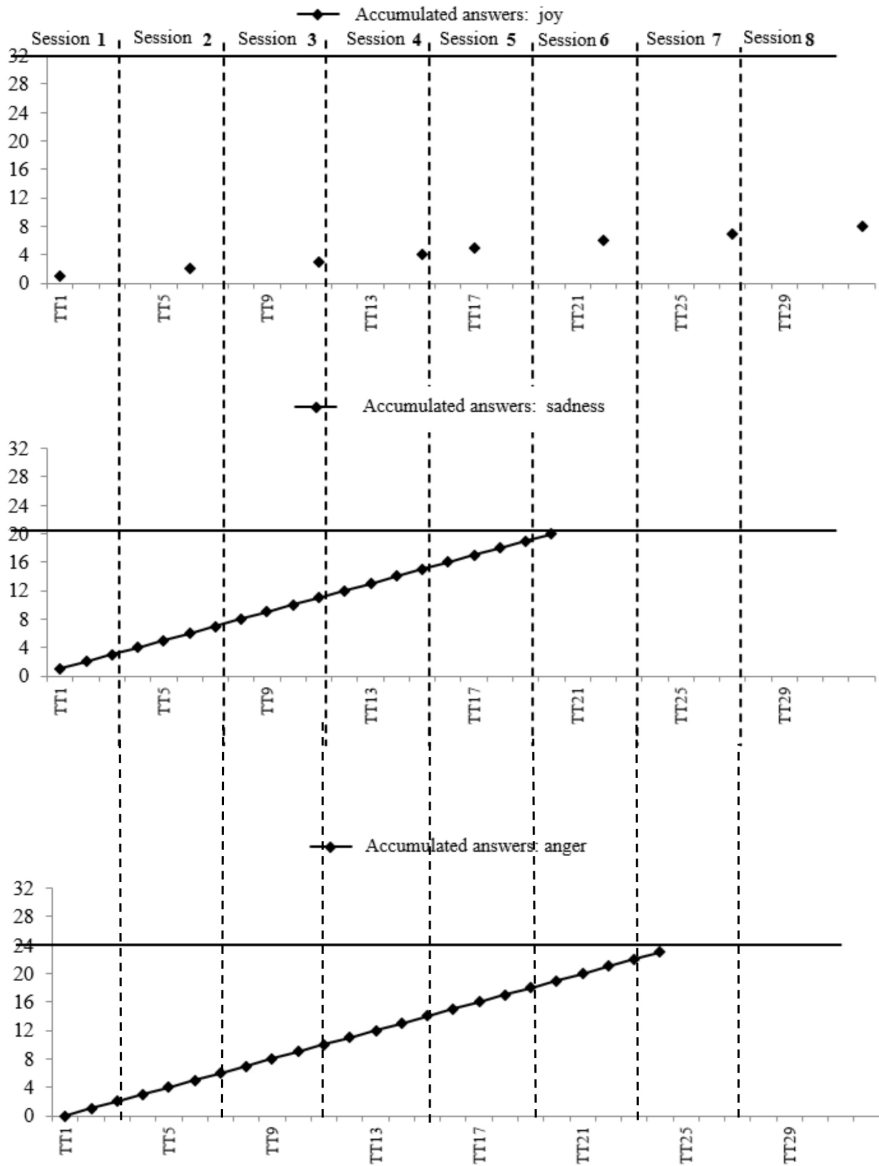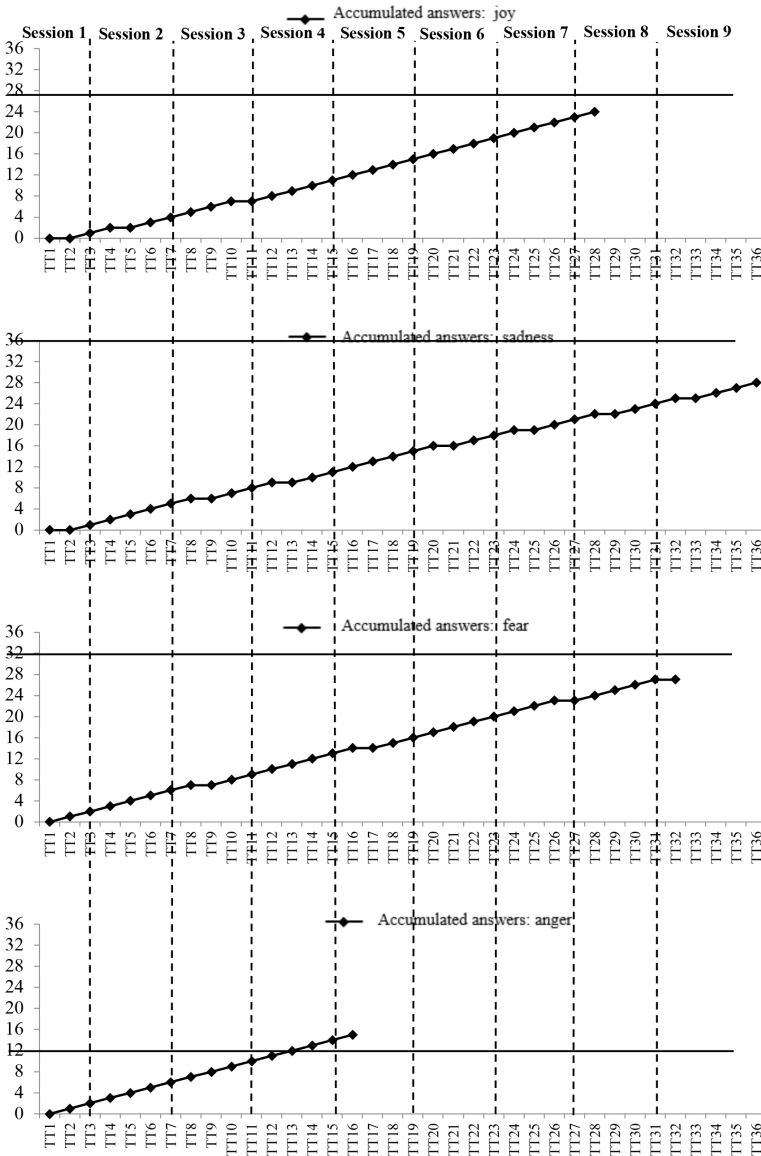*P2's performance on the books about joy, sadness, and anger.*

Figure 4 shows the number of P3's accumulated responses in the four social stories. The horizontal line represents the maximum number of correct answers for each story.

Figure 4

P3's performance in the four books.

The general analysis shows that M1 used only the book about joy with P1. Even though P1 presented only one independent answer throughout the intervention, the number of non-responses decreased when the mother provided cues (Figure 4). M2 read the books on joy, sadness, and anger (Figure 5). M2 read the books about joy, sadness, and anger (Figure 5). M2 allowed the child to try four attempts of answer per session (which was expected), except for the book about joy, in which the child was requested to try only one attempt. P2 showed improved performance, providing more correct answers over time. Finally, as shown in Figure 6, M3 read the four books for P3. P3 provided 24 correct answers out of 28 attempts in the book of joy; 28 correct answers out of 36 in the book of sadness; 27 correct answers out of 32 in the book of fear; and 15 correct answers out of 16 in the book on anger.

M1 started providing 100% of adequate instructions as of the 10th video. M2 started providing 100% of adequate instructions as of the 2nd video. Finally, M3 improved the number of adequate instructions as she sent the videos, especially when ENPE 1 is compared to ENPE 2. All instructions M3 provided to the child were adequate in her last videos (6 to 11). Regarding the cues mothers gave their children, the most frequently adopted was GC (n=15), followed by VC and TPC; M2 provided only VC. M3 more frequently provided VC, followed by GC, and lastly, DFP.

P1's performance suggests that his entry repertoire was insufficient to correctly answer the conditional discrimination tasks required in the intervention involving facial expression identification in the book's context. Such a situation occurred because the analysis of the data collected from M1 using the OPI instrument indicated that P1 presented the behaviors necessary to perform the experimental tasks (Figure 1). Hence, future studies are suggested to adopt instruments that assess conditional discrimination as an inclusion criterion to ensure participants have the minimum repertoire for performing the experimental tasks. Additionally, more refined strategies should be structured to collect entry repertoire data, considering such a measure is crucial for developing personalized teaching programs.

Table 4 presents an overview of all scores obtained in the EVALOF.

Table 4

EVALOF total and subscale scores

		Subscale 1	Subscale 2	Total
M1-P1	First week	11	20	31
	Final week	17	17	34
M2-P2	First week	23	20	43
M3-P3	First week	16	20	36
	Final week	16	25	41

EVALOF measures 32 items, and scores were expected to improve in the 18 items specifically addressing the behaviors in the mother-child interaction during the program implementation. Subscale 1 addresses these items, i.e., behaviors parents should display when structuring the teaching environment, the opportunities they give their children during interactions, and the children's responses. Subscale 2 measures encouraging verbal behaviors when the parents applied request models and provided instructions, as well as the children's responses to the arrangement proposed by their parents, and other verbal models such as teaching the child to synthesize and spontaneously manage themselves in a conversation and drawing conclusions.

M1-P1's score in Subscale 1 increased from the first to the last week, indicating that the quality of interaction between mother and child improved. However, there was no increase in the score of this pair obtained in Subscale 2. M3-P3's score in Subscale 1 did not change from the beginning to the end of the process. Nonetheless, this pair's score in Subscale 2 increased, indicating new verbal behaviors were acquired in the M3-P3 relationship. Comparisons were impossible for M2-P2, as they participated only at the beginning of the process. Regarding social validity, the mothers rated the service provided to the families well. M1 wrote, "I am very pleased and grateful that we were able to participate in this intervention, the objective of which was to get to know and understand my son better." M2 wrote, "It was good for me because I was able to learn a lot about how to deal with my little one's behavior." Finally, M3 wrote, "You were a 10. My son developed a lot with the activities".

Discussion

The children's performances, such as the number of answers they correctly answered in emotion recognition tasks in the context of stories were related to their performance in general socialization activities based on the premise that emotion recognition is a relevant aspect of any individual's social development (Petrovska & Trajkovski, 2019; Premkumar et al., 2020; Wieckowski et al., 2020; Garcia-Garcia et al., 2021; Li et al., 2023; Guo & Qiu, 2024; Tamas et al., 2024). Even though no statistical analysis was performed in this study to ensure this relationship between the teaching objectives (i.e., the impact of emotion recognition on general socialization performance), the results found here support a reflection, albeit embryonic, about this type of relationship. Thus, future studies are suggested to investigate these relationships in more depth. Although P1's number of independent correct answers regarding emotion recognition supported by the book on Joy ranged from zero (sessions 1 to 14, 16, and 17) to 1 (session 15), the analysis showed that the cues M1 provided helped the child to emit the correct answers; 100% of correct answers were obtained based on cues (n=4) in session 12. As for P2, except for the book on Joy, the analysis was compromised by M2's imprecise reporting and the lack of videos to validate the data. P2's performance in the remaining books replicated the same pattern of the socialization teaching objectives.

This study's results, especially in the initial sessions, corroborate the difficulties found by children with ASD in making conditional discrimination and recognizing social and emotional stimuli (Petrovska & Trajkovski, 2019; Premkumar et al., 2020; Wieckowski et al., 2020; Garcia-Garcia et al., 2021; Li et al., 2023; Guo & Qiu, 2024; Tamas et al., 2024). However, as the families provided differential consequences for the children's responses, the results changed, and improvement was found in the final sessions, going from 1 correct answer in session 1 for the book on Joy to 4 correct answers in session 7, for example.

Still on the discussion of children's performance in recognizing facial expressions, P3 performed better when identifying positive valence emotions than negative valence ones, corroborating studies by Muñoz, 2018 and Li et al (2023) regarding the difficulties of children with ASD in discriminating positive and negative emotions. A recent study by Tamas et al (2024) reports one finding that possibly explains these individuals' difficulties in differentiating positive and negative emotions: the dysfunction of neurological areas such as the amygdala, which is responsible for detecting and responding to threat information in ASD. Hence, the identification of negative emotions may become flawed in this population.

Regarding chronological age being a critical component in this teaching objective, this study's findings corroborate the literature (Li et al., 2023). For example, P2, who presents a higher chronological age (n = 6 years), performed better than his younger counterparts (P1 = 2 years old, and P3 = 3 years old). According to the literature, emotions are developed as an individual gets older and is exposed to social relationships. Hence, children learn to discriminate between emotions associated with situations more proficiently as they age. As noted by Li et al. (2023), both children with ASD and neurotypical children have the same learning possibilities as they age.

Another aspect concerns the effectiveness of using social stories (Silva et al., 2013) to teach facial expressions to people with ASD (Almeida et al., 2016; Lima, 2017; Petrovska & Trajkovski, 2019; Schimdt et al., 2020). The gains enabled by social stories corroborate Lima (2017), who also adopted social stories and successfully taught the recognition of four emotions (i.e., joy, anger, sadness, and fear). However, Lima (2017) noted that generalization is impossible if there is no contact with natural situations, as she verified that two of the three participants reached the learning criterion in this procedure in a natural environment that involved the family. Hence, the teaching procedure addressed here can be considered a viable tool for learning emotion recognition.

Furthermore, as verified in the studies by Petrovska & Trajkovski, 2019 and Li et al. (2023), children with ASD acquire emotion recognition skills better through cues given in social situations and discriminate better through pictograms and drawings, which reinforce this study's findings in which stories involving social situations were used to depict emotions.

One of this procedure's limitations concerns the absence of a specific baseline of emotions. Thus, future studies are suggested to pay attention to this phase when planning the intervention. Another limitation concerns the irregular number of videos sent by mothers and

incomplete records. Such a situation can be seen as inherent to data collection processes but presents challenges when one attempts to analyze the parameters commonly investigated in Behavior Analysis experiments. The challenges encountered in data analysis stemmed from data being collected remotely. However, the literature does not offer strategies to deal with these challenges, which underlines the need to consider the recommendations for the objectives established by future studies.

Additionally, the analysis of EVALOF (Balog, 2019; Balog et al., 2022) indicated the need to emphasize a technological limitation identified in this study's population: sending videos. Hence, alternatives must be considered to facilitate the families sending videos. Despite such a barrier, the behaviors of the mother–child pairs could be assessed when EVALOF was applied, which indicated improved scores were obtained from the first to the last sessions. The results found in this study replicate those reported in the literature about this instrument in situations involving the interaction between mothers and children at home.

The results regarding the mothers' engagement showed that all of them adhered to the project to some extent by sending the videos (though an irregular number of videos were submitted), asking questions, making comments through the technological messaging resource, and working on the teaching objectives weekly. The engagement measure lacks parameters, but this study operationalized, albeit introductorily, a way of analyzing such data, replicating the engagement found by Gomes et al. (2021), who also performed behavioral interventions mediated by technological resources.

The analysis of the mothers' engagement with social validity measures showed that M1 engaged the most (number of activities performed). For this reason, she obtained the highest score in the telehealth assessment. M2's results must be discussed in more detail. Even though she engaged the least (i.e., she sent the lowest number of videos and activities), she disagreed with the item "1.3 The activities were easy to apply." She checked option 1=totally disagree in the social validity questionnaire. Additionally, M2 is not Brazilian, and she might have found it challenging to understand the instructions for implementing the tasks. Therefore, future studies are recommended to apply the social validity questionnaire throughout the intervention rather than only at the end, as commonly occurs in the literature (Craig, Dounavi & Ferguson, 2022; Antill, 2020; Carneiro et al., 2020 & Gomes et al. 2021).

Final Considerations

This study was performed amid a global pandemic, and many adaptations were necessary to facilitate the intervention, such as using the remote telehealth care modality and asking the mothers to implement the programs. The primary objective was to investigate the procedure for teaching emotion recognition. However, due to contingencies, other objectives were established to promote the children's social development, and programs focused on the five areas of development were included, emphasizing social programs. The mother–child engagement and interaction and their participation in the study were also verified.

Despite the limitations previously explained, this study's objectives were achieved, as the children acquired new emotion recognition skills with the use of social stories, new social repertoires, and quality interactions were found between the children with ASD and their mothers during a period of social isolation.

Future studies are suggested to expand the teaching of emotions using social cues and characters, similar to the resources adopted in this study (social stories), to systematically improve results regarding teaching effectiveness when applied remotely, as well as parental training. The relevance of the parents' participation in implementing the programs and their proximity to their children in promoting child development in the family environment must be emphasized.

References

Almeida, C. G. M., Almeida-Verdu, A. C. M., & Cavalcante, M. R. (2016). Descrição de contingências durante a leitura de histórias e o comportamento de crianças: um estudo exploratório. *Psicologia em Revista*, *22*(3), 558–578. http://dx.doi.org/DOI-10.5752/P.1678-9523.2016V22N3P558

Antill, K. (2020). Family-Centered Applied Behavior Analysis for Children with Autism Spectrum Disorder. *Intervention in School and Clinic*, *55*, 185–191. https://doi.org/10.1177/1053451219842240

APA. American. Psychiatric Association. (2013). Diagnostic and Statistical Manual of Mental Disorders – DSM-V. 5. ed. Arlington, VA: American Psychiatric Association.

Balog, L. G. C. (2019). *Ensino da linguagem oral em contexto familiar: análise de uma ferramenta de observação*. Dissertação de Mestrado. Programa de Pós-Graduação em Psicologia, Universidade Federal de São Carlos, São Carlos, SP. http://repositorio.ufscar.br/handle/ufscar/11728

Balog, L. G. C., Domeniconi, C., Benitez, P., & Gràcia, M. (2022). *Ensino da linguagem oral no contexto familiar: uma ferramenta de avaliação*. São Carlos: UFSCAR/CPOI.

Braga-Kenyon, P., Kenyon, S. E., & Miguel, C. F. (2005). Análise Comportamental Aplicada (ABA): Um modelo para a Educação Especial. In: W. C. Júnior et al. (Orgs.), Transtornos invasivos do desenvolvimento: 3o milênio. Brasília: CORDE

Briot, K., Pizano A., Bouvard, M. & Amestoy, A. (2021). New Technologies as Promising Tools for Assessing Facial Emotion Expressions Impairments in ASD: A Systematic Review. Front. Psychiatry 12:634756. https://doi.org/ 10.3389/fpsyt.2021.634756

Carneiro, A. C., Brassolatti, I. M., Nunes, L., Damasceno, F. C. A., Cortez, M. D. (2020). Ensino de Pais via Telessaúde para a Implementação de Procedimentos Baseados em ABA: Uma Revisão de Literatura e Recomendações em Tempos de COVID-19. *Revista brasileira de análise do comportamento*, v. 16, p. 148–173, 2020. http://dx.doi.org/10.18542/rebac.v16i2.9608

Cooper, J. O., Heron, T., & Heward, W. (1989). Applied behavior analysis. Columbus, OH: Merrill.

Craig, E. A., Dounavi, K., & Ferguson, J. (2022). Effectiveness of a functional analysis and functional communication training conducted through telehealth. *Journal of Developmental and Physical Disabilities*, *35*(2), 227–246. https://doi.org/10.1007/s10882-022-09857-6

Domeniconi, C., Balog, L. G. C., Biazim, M. A., Moron, S. G., & Benitez, P. (2024). Telessaúde em intervenção comportamental com mães de crianças com autismo. *Revista Brasileira de Terapia Comportamental e Cognitiva*, *25*, 1–17. https://doi.org/10.31505/rbtcc.v25i1.1838

Fonseca, M. E. G. (2018). *Breve revisão sobre 24 práticas baseadas em evidências* (Manuscrito não publicado).

GarciaGarcia, J.M., Penichet, V.M.R., · Lozano, M.D., & Fernando, A. (2021). Using emotion recognition technologies to teach children with autism spectrum disorder how to identify and express emotions. *Universal Access in the Information Society*, 21:809–825. https://doi.org/10.1007/s10209-021-00818-y

Gomes, C. G. S.; Silveira, A. D.; Estrela, L. P. C. B.; Figueiredo, A. L. B.; Oliveira, A. Q.; Oliveira, I. M. (2021). Efeitos do Uso de Tecnologias da Informação e Comunicação na Capacitação de Cuidadores de Crianças com Autismo. *Revista brasileira de educação especial*, v. 27, p. 285-300. https://doi.org/10.1590/1980-54702021v27e0085

Guo, D.& Qiu,Z. (2024). Intrinsic Mechanisms of Facial Expression Recognition Defects in Children with Autism *Journal of Clinical Medicine Research*, *5*(1), p. 82. https://doi.org/10.32629/jcmr.v5i1.1789

Grelotti, D. J., Klin, A. J., Gauthier, I., Skudlarski, P., Cohen, D. J., Gore, J. C., et al. (2005). fMRI activation of the fusiform gyrus and amygdala to cartoon characters but not to faces in a boy with autism. *Neuropsychologia*, *43*(3), 373–385. https://doi. org/10.1016/j.neuropsychologia.2004.06.015

Higbee, T. S. (2012). *The ASSERT Curriculum* (Unpublished manuscript). Utah State University

Keating, C. T., and Cook, J. L. (2021). Facial expression production and recognition in autism spectrum disorders: a shifting landscape. *Psychiatr. Clin*. 44, 125–139. doi: 10.1016/j.psc.2020.11.010

Li, B., Blijd-Hoogewys, E. M. A., Stockmann, L., & Rieffe, C. (2023). The early development of emotion recognition in autistic children: Decoding basic emotions from facial expressions and from emotion-

provoking situations. *Development and Psychopathology*. Advance online publication. https://doi.org/10.1017/S0954579423000913

Lima, A. A. (2017). *Efeitos do uso de histórias infantis sobre o reconhecimento de expressões faciais de emoções em crianças com autismo* (Dissertação de Mestrado, Universidade Federal do Pará). Repositório da Universidade Federal do Pará. http://repositorio.ufpa.br/jspui/handle/2011/13848

MeyerLindenberg, H., Moessnang, C., Oakley,B., Ahmad,J., Mason, L., Jones, E.J.H., Hayward, H.L., Cooke, J., Crawley, D., Holt, R., Tillmann,J., Charman,T., BaronCohen, S., Banaschewski, T., Beckmann,C., Tost, H., MeyerLindenberg, A., Buitelaar, J. K., Murphy,D.G., Brammer,M.J., & Loth, E. (2022).Facial expression recognition is linked to clinical and neurofunctional diferences in autismo. *Molecular Autism*, *13*(43). https://doi.org/10.1186/s13229-022-00520-7

Muñoz, P. O. L. (2018). *Rastreamento de olhar e reconhecimento de emoções em crianças com transtorno do espectro autístico* (Tese de Doutorado, Universidade de São Paulo). Biblioteca Digital Usp. http://doi.org/10.11606/T.47.2018.tde-19122018-100632

Paracampo, C. C. P., Albuquerque, L. C. D., Mescouto, W. D. A., & Farias, A. F. (2013). Efeitos de perguntas e de respostas às perguntas sobre o seguir regras apresentadas em uma história infantil. *Psicologia: Teoria e Pesquisa*, *29*(4), 369-379. https://doi.org/10.1590/S0102-37722013000400003

Petrovska, I.V. & Trajkovski, V. (2019). Efects of a ComputerBased Intervention on Emotion Understanding in Children with Autism Spectrum Conditions. *Journal of Autism and Developmental Disorders*. https://doi.org/10.1007/s10803-019-04135-5

Piccinini, C. A. et al. (2001) Diferentes Perspectivas na Análise da Interação PaisBebê/Criança. *Psicologia: Reflexão e Crítica*, *14* (3), 469–485. https://doi.org/10.1590/S0102-79722001000300004

Prem Kumar, K., Murugapriya, K., Varsha, M. R., Asmitha, R., & Sureka, S. (2020). Facial Emotion Recognition for Autism Children. *International Journal of Innovative Technology and Exploring Engineering*, *9*(7), 1274–1278. https://doi.org/10.35940/ijitee.F3772.059720

Rosset, D. B., Rondan, C., Fonseca, D., Santos, A., Assouline, B., & Deruelle, C. (2007). Typical emotion processing for cartoon but not for real faces in children with autistic spectrum disorders. *Journal of Autism and Developmental Disorders*, *38*, 919–925. https://doi.org/10.1007/s10803-007-0465-2

Schmidt, A.; Domeniconi, C.; Paulo, L.; Gracia, M. (2020). Learning Pseudowords Through Shared Storybook Reading And Auditory-Visual Pairing. *Trends in Psychology*, *28*(4), 569-584. https://doi.org/10.1007/s43076-020-00035-1

Silva, A. P. C., Del Prette, A., Del Prette, Z. A. A. (2013). *Brincando e Aprendendo Habilidades Sociais*. Paco Editorial.

Skinner, B. F. (1953). Science and human behavior. New York: Free Press.

Tamas D, Brkic Jovanovic N, Stojkov S, Cvijanović D, Meinhardt–Injac B (2024) Emotion recognition and social functioning in individuals with autism spectrum condition and intellectual disability. *PLoS ONE*, *19*(3): e0300973. https://doi. org/10.1371/journal.pone.0300973

Uono, S.,· Sato, W., Kochiyama, T., Yoshimura, S., Sawada, R., Kubota, Y., Sakihama, M., & Toichi, M.(2022). The structural neural correlates of atypical facial expression recognition in autism spectrum disorder. *Brain Imaging and Behavior*, *16*:1428–1440. https://doi.org/10.1007/s11682-021-00626-1

Webster, P. J., Wang, S. & Li, X. (2021). Review: Posed vs. Genuine Facial Emotion Recognition and Expression in Autism and Implications for Intervention. *Front. Psychol*, *12*, p. 653112. https://doi.org/10.3389/fpsyg.2021.653112

Wieckowski, A. T., Flynn, L. T., Richey, J. A., Gracanin, D., & White, S. W. (2020). Measuring change in facial emotion recognition in individuals with autism spectrum disorder: A systematic review. *Autism*, 1-22. https://doi.org/10.1177/1362361320925334

Williams L. C. A., Aiello A. L. R. (2001). *O Inventário Portage Operacionalizado: intervenção com famílias*. Editora Memnon.

Contribution of each author to the work:

Ricardo Martinelli Bondioli: Conceptualization, Methodology, Data Collection and Analysis, Writing of the Article.

Miriana de Araujo Biazim: Data Collection and Analysis, Writing of the Article.

Camila Domeniconi: Conceptualization, Methodology, Data Collection and Analysis, Writing of the Article.

Priscila Benitez: Conceptualization, Methodology, Data Collection and Analysis, Writing of the Article.