Autism, Expression, and Understanding of Emotions: Literature Review

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Abstract—In recent years there has been a growing interest in autism spectrum individuals in the expression and understanding of emotions. The objective of this work is through a literature review: a) to illustrate the emotional development and education of individuals on the spectrum b) to present the findings of investigations c) to present and raise key concerns about the emotional intelligence of children spectrum of autism (d) raise questions about the development of educational methods aimed at enhancing the emotional development of individuals in the autism spectrum and thereby the development of social feelings their maternal skills.

Keywords—Autism, autism spectrum, emotional intelligence

1 Introduction

Autism Spectrum Disorder (ASD) is a lifelong developmental disorder that prevents people to understand correctly what they see, hear and generally feel. As a result, they face serious problems in their social relationships, communication, and behavior. Children with autism spectrum have significant difficulties in recognition, in understanding and expressing emotions [1]. They tend to avoid human faces and are difficult to understand why facial features are "moving", changing, as a result, the inability to read the emotions in the human face weakens their ability to communicate with other people [2]. The purpose of this paper is to present a literature overview research on how people's emotions are expressed and understood in the autism spectrum, as well as research on investigating the training of autistic people in recognizing, expressing and understanding emotions.

2 Autistic Spectrum Disorder (ASD)

Autistic Spectrum Disorder is a severe, widespread developmental disorder a person who has been accompanying the person throughout his or her life, affecting their perception, thinking and behavior and is characterized by (a) significant difficulties in developing the person's social and communication skills and mutual

interactions with those around him, and (b) limited and recurring stereotypical interests and behaviors. [3], [4]

ASD is diagnosed by comparing one's behaviors with symptoms that are listed in the official Diagnostic and Statistical Manual of the American Psychiatric Association (DSM-V) and the World Health Organization (WTO) ICD-10 (International Classification of Diseases) lists. Both the current diagnostic criteria and the descriptions of modern researchers that concerning the Autism follow Wing's "Triple Disorder of Social Interaction": a) Disruption of social relationships - incomplete social interaction - interaction, lack of emotional reciprocity, social b) Communication disruption - inadequate communication and communication) and fantasy - a lack of social understanding and imagination (Happe, 1998). These three categories, with the revised version DSM-V, were replaced by 2 groups: a) social communication and b) stereotyped, repetitive behaviors, activities, and interests.

It should be emphasized that children with ASD are highly heterogeneity in terms of social disorder. Other children have a lack of motivation for interaction, which in some cases avoids interaction, that is, they avoid touch and eye contact, while others actively seek interaction but either lack empathy or interact interactively. People with ASD also have a disadvantage in their emotional organization, resulting in difficulty in communicating with those around them, with consequences for socializing and family problems.

3   Emotional Intelligence

The individual coexists with logic and emotional intelligence. The feelings they have important in one's life because as a subjective response of the person to the event that caused the emotion, they have the potential as an internal ethic to guide us in decision making, changes in behavior, facial expression, and posture. Scientists pointing out the importance of emotional intelligence in achieving personal and collective goals emphasize that most of the time, one's general intelligence does not guarantee success unless it is combined with a high degree of emotional intelligence.

The term intelligence has been given definitions that primarily refer to the intelligentsia one's achievements and not so much what intelligence is,[5] points out. Cognitive intelligence defines what we can measure ", while the scientific definition defines:" intelligence is a complex and complex cognitive function, involving many factors, including the ability to acquire new experiences, adapt to new situations. and to build on previous experience in dealing with new difficulties or problems "[6], [7]

The feeling from ancient times is defined as: "a function of the body, the which either alone or in collaboration and interaction with mental functions contributes to the overall development of man and enhances his ability to adapt. " [5]. In Psychology, the term emotion was first used in the mid-18th century by Hume to describe passion or love [8], while in modern theories: Fredrickson's theory of positive emotions [9], [10] but also in previous theories[11], [12], [13], the term emotion expresses the multidimensional forms of the organism's response to environmental challenges, manifested at various levels, such as expressive, cognitive,

neurological, normal or biological, etc. [5] and seems to be accepted today by most psychologists who study emotions.

The term "emotional intelligence" was recently used by Goleman [14], [15], while its development as a scientific concept began long ago and has its roots in Thorndike's social intelligence [16]. "Emotional Intelligence" is a multidimensional concept and therefore exists several definitions, depending on the aspect of emotional intelligence that scientists are trying to cover, although most analyze emotional intelligence in four thematic areas: perception, understanding, control, and the use of emotion. It is treated "as a complex concept that encompasses a range of dimensions (abilities, characteristics, skills) and refers to various areas of human nature (cognitive potential, personality, behavior)" [17].

According to the Greek Dictionary: Emotional Intelligence is defined as "the ability to control one's emotions, to cope with emotional stress, to develop one's abilities in areas such as imagination, art and human communication ", while according to Goleman [15] it is defined as" the ability to know what you are feeling and to be able to handle these emotions before letting them handle you, to be able to motivate yourself to accomplish your goals, to be creative, to make the most of your abilities, to understand what people are feeling others and be able to handle their relationships effectively. " Finally, Salovey, Mayer, & Caruso [18] define emotional intelligence as "the ability of a person to identify, accurately evaluate, and distinguish his or her own, others' emotions, to understand, to" assimilate "them into their minds, and to regulate both negative and positive emotions in oneself and others. "

In recent years they have been measuring and evaluating emotional intelligence manufactured various psychometric tools (scales or tests), both scientifically and popularly. [17].

Researchers support that there is a positive correlation between emotional intelligence and one's cognitive processes, and this demonstrates the important role that emotional intelligence plays in emotion and cognition, thereby enhancing individuals and their personality and benefiting [19], [20]. They also emphasize that emotional intelligence is a skill that can be "learned" and developed. [21], [22].

Researchers Dringas & Papoutsi [23] support in their research that the development of emotional intelligence is based on the 9-level model. This model is based on the concepts of Gardner's interpersonal and interpersonal meanings [24], [25].

The pyramid of emotional intelligence (9-level model).

- 1. Emotional Unity
- 2. Exceeding
- 3. Homogeneity of Emotions, Realization
- 4. Social Skills, Expertise in Emotions
- 5. Social Awareness, Empathy, Discrimination of Emotions
- 6. Self-management
- 7. Self-knowledge
- 8. Recognition of emotions, perception-expression of emotions
- 9. Emotional stimuli

Man strives to reach the last level of the pyramid, and at every level cultivates important emotional, cognitive and metacognitive skills that are important resources.

4 Emotion and DAS: Expression-perception-understanding of emotions

Feelings are the first way children communicate as well as the first weeks of their lives are capable of expressing their core feelings of joy, sadness, anger, disgust, and surprise. [26]

Leppanen & Nelson [27] support that one's ability to discern a person's sense of facial expressions is considered essential for successful social interaction, and conversely, social interaction, through increased experience in facial expression, may be necessary for normal development of facial emotion recognition (Facial Emotion). Recognition, -FER). Many people with an autism spectrum disorder, who are characterized by severe difficulties with social interaction, have experienced impairments in FER. Kanner [28] first described autism as a "disturbance of emotional contact", emphasizing the social and emotional characteristics of autism disorder and argued that it is "inherently" inability of children to develop emotional contact with other persons, weakness they continue to emphasize social and emotional deficits and the role of emotions in DIA is still under discussion. The taxonomic systems of the World Health Organization ICD-10 and the American Psychiatric Society DSM-V in the criteria for diagnosing autism spectrum status related to deficits in the recognition and processing of emotions emphasize: "Deficits such as nonverbal behavior manifest; the facial expression "and" lack of social or emotional reciprocity ". These difficulties in using and responding to emotions correspond to two components of the processing of emotions [29], [30], [31], the production of an emotional state and the regulation of emotions. [32].

Researchers agree that in typically developing children the recognition of Emotional facial expressions are an early development of social skills [32] from the age of 4 months we distinguish expressions of anger, fear, sadness, happiness and surprise in infants [33] in a familiar context while between 8 and 10 months infants begin to use emotional expressions for social reference [34], and are a key source of information about the sender's current emotional state [35], intentions [36] and the significant if environment and lessons learned [37], [38]. The failure of these fundamental emotion recognition skills will have serious consequences for the child's social development, moving the child away from learning about other people's emotions and reactions. [32].

In ASD, when we talk about a basic disorder of feeling we do not mean that children with ASD have no emotions, nor the difficulty of children to read the feelings of others and to reflect on their own, but this is a disorder of the connection of emotion with perception and thinking, difficulties in understanding, managing of emotions and personal meaning in what the child perceives. This is why scientists argue that children with ASD can express their emotions, but their emotional expressions differ from those of typical developmental children [1].

5 Method

In the present work, reference is made to research on expression, perception and understanding emotions in DIA. and categorized into two categories: a) research on the recognition of emotions of people with autism and b) research on the development of emotionally-empowering people with autism.

Research on the emotional intelligence of people with ASD, in particular, has increased in the last decade, but the findings on the recognition of facial emotions in autism are inconsistent: some studies find no deficits in autism, while others report deep deficits [39], despite numerous studies, there is still no general acceptance as to whether emotion recognition is a fundamental difficulty for people with autism or not. Several of these studies have identified difficulties in the recognition of facial expressions in individuals with autism [40] , [41], [42], [43], some other studies have not [44], [45], [46], [47], [48], [49], while studies indicate deficits that are limited to specific negative emotions, such as fear [50], [51], disgust, sadness, and anger [52], [53].

The literature review refers to the results of 48 surveys, collected by Uljarevic & Hamilton [32], with 980 participants with ASD of all ages. They focused on the recognition of emotion from visual stimuli because they have been studied more and are intended to determine whether recognition dysfunction exists at all ages of autism, regardless of IQ and severity level, and whether deficits in recognition of visual impairments and equivalents in size in all different emotions, The criteria set included: sample number, autistic gender and control group, diagnosis and diagnostic criteria , the mental age of the participants, the type of project, the research tools and the emotion study category (basic or complex). The results of the literature review showed that there was an objective difficulty in identifying emotions from people with autism and that the age of the participants, their IQ and performance had no effect on the sample performance.

Finally, issues that need to be addressed in subsequent investigations were identified such as sample size, sample group, and the projects used [39], [54], [55], [56].

Also, a new search [57] was limited to 31 articles about serious games, between January 2001 and April 2014, and they were designed to improve social skills. Sixteen of these games targeted facial emotion recognition or production. They support that "Although social skills required in real-life involve rich combinations of perspective-taking, emotional regulation, cognitive flexibility, appropriate use of language and so on, the literature search conducted here emphasized that a significant part of the effort devoted to serious game design has been focusing on the basic ability of emotion recognition, which sustains those more complex forms of social competencies"

5.1 Surveys of expression, recognition, and understanding of emotions

Hobson [58] supports that the cause of autism is the inability of individuals to create emotional bonds with other people as they do not have the subjectivity of

recognizing emotions. The absence of this is the inability of the individual to perceive emotional states and to understand the minds of others [58], [59], [60], a view supported by researchers. [61], [45], [62], [63], [64], [65].

Hobson, Ouston & Lee [66], [67], also support that autistic individuals find it difficult to grasp the emotional expressions in both their reading and their understanding of the faces of others, because autistic children do not see the person as a single form (Gestalt) but as a set of elements that are related in a specific way so they can identify them in the experiment.

Other research reveals the inability of autistic children to interact and express their feelings in expressions, not verbally. [1]. Yirmiga, Kasari, Sigman, & Mundy [69] by videotaping the interactions of autistic, mentally retarded, and typically developing children with an unknown adult and studying their reactions, concluded that autistic children express abnormal or control, a view supported by Dawnson, Hill, Spencer, Galpert & Watson [70], while Kasari, Sigman, Mundy, and Yirmiya [71] agree that autistic children find it difficult to express their emotions when interacting with an adult. .

Baron-Coen [72] in two studies asked children with ASD to describe their the emotional state of a heroine and studied the difficulty of autistic children in understanding emotions, asking whether it is the difficulty of autistic children to understand primary anomalies [58] or the secondary consequence of Frith & Leslie [74]. The conclusion was that children with ASD difficulty in understanding beliefs are a primary deficit, but the difficulty in understanding emotions is a secondary consequence, that is, autistic children understand certain situations or events that cause specific emotions.

In addition to research on understanding and expression of basic emotions, research has been conducted the ability to perceive, understand and express complex emotions of people with ASD. Researchers Klim, Volkmar, & Sparrow [75] studied the basic social behaviors of children with ASD, aged about 4 years with control groups of typical developmental children and children with intellectual disabilities, aiming to show that social behavior or lack thereof is independent of the kinetic activity of the individual. Research has shown that autistic individuals cannot develop emotional bonds with others, reinforcing the view that socialization is one of the three deficits of autism [76] and their inability to connect emotionally with others. it deprives them of social experiences.

Baron-Cohen,[77] thinks that children with autism are deficient in autism "Theory of mind", in understanding others' mental states, resulting in difficulties in understanding one's beliefs, desires, intentions, feelings and interpreting the behavior of others. Misailides & Papoudi, [1] report that researches related to "theory of mind" have shown that children's performance in autism in recognition of complex emotions in facial expressions in photographs was commensurate with children's performance in works. theory of mind, while Heerey, Kethner & Capps [78] believe that the disorder of people with autism in the understanding, perception, and expression of complex emotions is due to the abnormal development of the "theory of mind" that is necessary for the development complex emotions, as complex emotions usually manifest themselves when other people are present.

In a study of Rump, Giovannelli, Minshew & Strauss [79] with 2 experiments investigated the recognition of emotions in typically developing individuals and people with autism at different ages. The results showed that the performance of the subjects in the control group was better in the adult group, while the performance of the individuals with autism was similar in all age groups, that is, the adults with autism did not seem to reach the level of aptitude recognition about to with concerning the emotions, typically developing adults.

Harms et al. [39] also refers to the results of optical surveys Coordination (Eye-Tracking) and Brain-Based Studies pointing out that the results show that people with ASD exhibit abnormalities in the recognition of emotional facial expressions. Wallace, et al. [53] exploring the recognition of his emotional expressions facial and perceptual sensitivity between high-functioning autistic adolescents and typically developing adolescents (corresponding age, IQ, gender) in six key emotions and examining the links between recognizing emotional facial expressions and adolescent symptom / adaptive functioning, people with high functioning autism have difficulty processing emotional facial expressions, perceptual sensitivity, and sad expressions. ye not associated with autistic behavior and adaptive functioning, which may be considered as in-awareness deficits.

In a recent, study Tanaka, et. al. [80] evaluate the expression process participants with autistic disorders designed and used the computer project "Let's Face It! Emotion Skills Battery" (LFI!) Consisting of three measures of verbal and perceptual facial recognition skills. It was administered to groups of participants with ASD and typically developing individuals of the same age and intelligence (IQ). The results of the studies showed that people with autism were able to identify basic facial emotions (except for anger expression) at the same level as typically developing control subjects, but with a reduced ability to generalize emotions to different identities. Researchers have made suggestions for designing effective emotion processing interventions promoting the generalization of emotion recognition in people and social situations to enhance social day-to-day skills.

Last discussed that responsible for the impairment of emotional ability is the malfunction of the almond nucleus, the sickle [81]. The almond nucleus plays a key role in emotional learning, regulates additional cognitive processes, such as memory or attention [82], while stimulating it produces negative emotions (fear, sadness, anxiety) or positive emotions (happiness). Researchers Bauman & Kemper [83] in necrotizing studies of the autopsy of the sickle-cell of the autopsy showed that there were abnormalities in the size, density and dendritic branches of the autopsy. and found these findings to be evidence of abnormal development of the autistic almond kernel [1], a view also supported by research in animals such as Bachevalier, Hagger & Mishkin [84] rhesus, as well as those of Prather et al. [85] and Emey et al. [86] in monkeys with localized damage to the tonsils, showed that macaque monkeys with damage to the tonsils showed a lack of fear in stimuli that typically cause this emotion [1].

Grossard, et.al [57] mention that many serious games focus on recognizing emotions in pictures, drawings, audio or video recordings. Although emotion

recognition is multimodal [87], visual facial stimuli were the most frequent, audio stimuli were less frequent and body posture presentations were only proposed once.

5.2 Emotional development and autism spectrum training

Individual and minimal surveys have been conducted to investigate, based on different intervention models and in a different population of autistic individuals, whether children with ASD can be trained in understanding and expressing emotions. Personalized psychoeducational intervention programs specifically aimed at teaching emotional comprehension skills for children with autism do not exist while integrated intervention programs have so far been developed and applied to autistic children, e.g. Lovaas, PECS, TEACCH, etc., aim to improve the behavior of autistic children and to train them in communication and social skills.

Based on the principles of behavior analysis, Gena, Krantz, Mc Clannahan and Poulson [88] conducted a study with 4 autistic individuals aged 11-19 years and aimed at: teaching socially acceptable emotional reactions to autistic individuals using the combination of: reinforcement, imitation and verbal guidance, to evaluate the effects of intervention with new therapists and in new situations after the arrival of one month, and to train autistic people in emotional states related to acceptance by their peers. The categories used to train autistic people were: 1) talking about favorite objects, 2) laughing at nonsense, 3) showing sympathy, 4) showing appreciation, and 5) showing dissatisfaction. Indicative socially acceptable emotional responses were considered: eye contact, as well as socially acceptable verbal response and emotional expression. Participants were trained in 3 or 4 categories, and the results of the study showed that all 4 participants benefited by presenting socially acceptable emotional reactions, not only to the categories they were trained to but also to new situations with new therapists and after one month.

Hadwin, Baron-Cohen, Howlin, and Hill [89], [90] studied, in the context of 'theory mind how children with autism aged 4-13 years and verbal age 6 years can be taught to understand emotions, beliefs, and pretensions. The findings of the study showed that autistic children could be taught and succeeded in tests that assessed the above while retaining this ability after a 2-month evaluation, but it was observed that there was no generalization to unstructured activities with a different structure from the ones originally developed. Children were trained and that this intervention did not contribute to improved communication in terms of the use of mental states and the ability to expand into discussions.

In another study, Silver, and Oakes [91] using the program Emotional Computer-assisted trainers teach people with autism or Asperger's syndrome to recognize and anticipate others' emotions. The study involved 2 groups of 11 participants each, aged 12-18 years old and verbal aged 7 years and over, with a diagnosis of autism or Asperger's syndrome. The experimental group used the program for 10 episodes lasting 30 minutes over for 2-3 weeks while the control group subjects were watching their class. Participants were assessed before and after the intervention using photos with the 4 basic facial expressions, photos that refer to a person in a particular emotional state that triggers the expression of a particular emotion, photos showing

what the protagonist wants, what he or she is getting. finally and how it finally feels and photos referring to a person and a particular situation triggering emotional reactions The results of the intervention They showed that the experimental group showed improvement in all parameters compared to the control group and that the scores on emotion measurements were not correlated with age or verbal ability, and the more they used the program on the computer, the more positive results there were. However, it remains to be tested whether these positive effects can be generalized in real life or contribute to better performance in measurements of mind theory.

Bauminger [92] used the principles of cognitive-behavioral therapy in a sample of 15 autistic individuals aged 8-17 years and Intelligence Score 60-109 on the WISC-R to evaluate the effectiveness of an intervention on socio-emotional understanding and social interaction. The intervention lasted 7 months for 3 hours a week at school by the child's teacher in collaboration with a peer and his parents. Intervention with emotional comprehension included teaching: basic emotions describing the rules for each emotion, recognizing emotions in oneself and others through recognizing emotional expressions, gestures and utterances, and recognizing emotions. Intervention results showed that people with ASD: recognized and described more emotions, used more complex emotions taking into account the presence of others, and reported personal emotional experiences more frequently than using standard stereotypical responses.

Golan et al [93] used computers to identify and emotion learning educational software "The Transporters", a digital game for 4-8 -year- olds [94]. This software is a series of animations with 'live' vehicles, eight characters with real human faces designed to enhance the learning and understanding of emotions in children with ASD and plays in a child's bedroom, in a predictable environment. The study sample included 20 children with autism, aged 4-7 years, who attended the game daily for 4 weeks and were examined before and after intervention in emotional vocabulary and emotion recognition at three levels of generalization. They were compared with two child control groups: the first group of 18 children with ASD and the second group of 18 children with formal development. The intervention team showed significant improvement, and the researchers concluded that using the software improved the recognition of emotions in children with autism [93].

Researchers Hopkins, et al. [95] used the FaceSay program, one an interactive avatar computer program designed to teach social skills and improve the social interactions of children with ASDs in the natural environment, to increase their ability to observe globally the interpretation of emotions in faces. Faces are one of three games designed to improve attention skills and is based on the idea that people with autism are deficient in central cohesion [96]. The study evaluated the efficacy of FaceSay activities in 49 low- and high-functioning autism spectrum participants and had the opportunity to practice eye gaze, facial expressions and face recognition and emotion recognition in the structured environment of FaceSay. Low-functioning children showed improvements in emotion recognition and social interaction, whereas high-functioning children showed improvements in face recognition. The findings are particularly encouraging.

The researchers, Machalicek, W.K. Others, [97], in a systematic review of studies, using computational interventions (CBI) to improve the social and emotional skills (eg, emotional recognition) of people with autism spectrum disorder (ASD), report that these results studies have shown that the effect of CBI on social and emotional skills was mixed, with most studies reporting unacceptable results after intervention and pointing out that the comparison of CBI training with guidance and personal social skills training suggests that the CBI can be just as effective as face-to-face education. In general, this review indicates that the use of CBI to improve the social and emotional abilities of people with ASD is a promising practice. They caution professionals that they should carefully consider the preferences and existing capabilities of people with ASD and adjust the software when deciding to use the CBI and choosing a software program

Grossard, et.al´,[57] at his article support that four games of the sixteen, also trained on producing emotions, often by having individuals mimic a model. Among them, only Life- IsGame [98] includes emotion production exercises in a social context with no visual support.

The researchers Tan et al., [99] fixed up the game" CopyMe". It's a very simple game in its architecture and principles and has not been tested in a clinical study. targets only facial expression production; the game is designed for an iPad. The player must look at a picture of a facial expression with the name of the expression written underneath it and then she/he has to reproduce it. There are 3 levels of difficulty: the easy level includes happy and sad emotions; the intermediate level includes happy, sad, angry and surprised; and the difficult level includes happy, sad, angry, surprised, scared and yucky. A facial expression recognizer was built for this game.

Serret et al., [100], fixed up the game. "Je Stimule" This game is a computer game that targets expression recognition in context, more complex in its computation and was tested in an open stratified clinical trial. This game is separated into 2 modes, training and the game itself. The particularity of this game is that Lf-Asd (Low Functioning Autism Spectrum Disorders) Individuals can play using color codes that are associated with specific emotions (yellow for joy, for example). Players learn these codes in the training mode. During the game, the player moves her/ his avatar in a 3D environment and is exposed to different scenarios during which she/he has to recognize emotions. Different levels of recognition exist: (1) recognizing the emotion expressed by a virtual character due to a specific event (e.g. a child falls); (2) the same task but the face of the virtual character is hidden; (3) recognising the emotion conveyed by the non-verbal communicative behaviour of a virtual character speaking with another virtual character when the verbal exchange is made inaudible.

6   Conclusions – Perspectives

The results of the literature review to the results of 48 surveys collected by Uljarevic & Hamilton [32] showed that there was objective difficulty in identifying emotions from people with autism and that the age, participants, their IQ, and the task used had no effect on sample performance.

The researchers noted that there are critical issues that need to be addressed. Future research concerns: sample size, sample group, and projects used [39], [101], [102], [103]. Based on the evaluation studies, they recommend using larger sample sizes to increase the reliability and reproducibility of the data, to fully record the results (tables, graphs) for better documentation. They also raise questions about how important time is in recognizing emotion, and people with autism may need more time to recognize an emotion, or they may have difficulty recognizing emotions in moving dynamic images from still images. The second concern they have is that there is a greater failure to recognize negative emotions than people with ASD, and they suggest more research with different emotions with large groups of participants in combination with brain-imaging and visual resonance methods.

In Grossard's et al [57] review is presented the presence or absence of the different attributes of serious games described by Yusoff [104]. Games usually included several attributes. However, three attributes appeared to be used less frequently: attention span, reward and accommodating the learner. Each game was very different with variations based on the authors' choices.

Also, at the same review is presented the scale scoring from Connolly's et al. [105] study regarding clinical validation. Excellent scores were obtained only 6 games from sixteen games: The Junior Detective Program [106], Emotion Trainer [80] FaceSay2 [47], JeStimule [100] Let's Face It [80] Mind Reading [107] and The Transporters [93]. Regarding the targeted populations, 6 serious games are available exclusively for high-functioning (HF) ASD or Asperger syndrome (AS) individuals, with no adaptation for low functioning (LF) ASD patients. Two other games require that players have good reading skills. Among the 16 games, 10 were assessed in populations with ASD, only 7 studies used a control group, including a few with sample sizes of 30 or more children per group and only 4 studies were randomized. Also, one study (the serious game Let's Face It!) [80] included both a control group and an ASD group matched for developmental age and diagnosis (AS or PDD-NOS) and more than 30 children per group. In terms of efficacy, the individuals who played Mind Reading [107] The Transporters [93], JeStimule [100] FaceSay2 [47], The Junior Detective Program [106], and Emotion Trainer [80] showed improvement after training but their results cannot be extended to the whole spectrum of autism disorders given the limited representativeness of their samples. Also, no study showed evidence of clinical relevance meaning that by playing with a serious game that focuses on social interaction skills, the children were not shown to improve clinical social interaction scores (like ADOS or Vineland).

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