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The development and content validity of the emotional recognition memory training program (ERMTP) for children with autism spectrum disorder: A trial phase

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ABSTRACT

Background: Facial expression, tone of voice, body language, and context are unrecognizable to children with autism. Emotional arousal and emotion recognition (required emotion empathy and cognitive processing empathy) induce downstream illnesses in children with ASD. Thus, the proposed study aimed to develop a computer-based Emotional Recognition Memory Training Program (ERMTP) for ASD.

Objective: Firstly, to develop and validate the ERMTP for social cognitive abilities in children with ASD and secondly, to conduct pilot-tested it in typically developing children and children with ASD.

Materials and methods: This study consisted of 3 phases. The first phase was developing the ERMTP from the literature review. The second phase was analyzed for content validity with five experts about Task 1 (two activities) and Task 2 (nine activities) comprising ERMTP. Computer-based learning of six fundamental facial emotions (happy, sad, angry, fear, disgusted, and surprised) improves social cognition. Finally, the pilot test was analyzed to discover the ERMTP's challenges for five children with typical development and ASD.

Results: The ERMTP's activity items have good content validity, especially regarding clarity and relevance. All five raters gave the intervention a 1.0 IOC for its distinct components. In the training program, we followed the expert instructions regarding background music or voice and the generalization task. Descriptive analysis indicated that all five normal-developing children followed emotional expressions and instructions (100%). All five parents reported there were changes in focus and memory skills. Emotion regulation, memory abilities, and the social cognition index demonstrated statistically significant (p<0.05) effects before and after ERMTP treatment in ASD.

Conclusion: ERMTP seeks to improve the social cognition of children with ASD by the use of feedback from both specialists and the children themselves. However, further research will be necessary to investigate ASD using a randomized control trial.

Introduction

Autism spectrum disorder (ASD) is a group of neurodevelopmental disorders that start in utero and last a lifetime.[1] In the first three years of life, ASD causes communication, social interaction, and stereotyped behavior issues.[2] Individuals with autism spectrum disorders with excessive emotional arousal and cognitive issues.[3] Heart rate, pupil dilation, and skin color vary with emotional arousal. These include six strong fundamental emotions (happy, sad, anger, fear, disgusted, and surprised) and many complicated emotions (arising from mental

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state, situational context, and culture) via emotional arousal.[4] Emotional arousal is a fight-or-flight reaction. The emotional arousal drive is the fundamental process that initiates and executes all actions.[5] Emotional arousal reflects both positive and negative expressions of experience. The significant role of emotional arousal is to make a person pay attention and develop memory skills.[6,7] Hyper levels of emotional arousal trigger stress and cause poor emotion recognition (ER) memory in children with ASD.[8]

ER is the ability to understand and identify human emotions.[9,10] ER is the aptitude to attend to social interactions by understanding the individual's facial expressions, tone of voice, and body language. These abilities arise from emotional empathy (affective empathy/cognitive empathy) and mental functions (social orientation/attention, the theory of mind, working memory, episodic memory, and social awareness). Regarding emotional empathy, the 'systemizing' (cognitive) empathy component is the capacity to identify or recognize other people's problems and respond appropriately to their mental state and emotions. For example, it is the ability to share an emotional experience, feel distressed in response to someone's pain, and be willing to help someone.[10] The affective (emotion) empathy component is the emotional reaction (neutral, happy, sad, anger, fear, disgusted, and surprised) to another person's mental state.[11] In social cognition, ER is essential for people to be successful in their everyday functions of communication and social interactions.[12]

The occurrence of emotional regulation (ER) difficulties has the potential to contribute to the development of mental health challenges, particularly in those diagnosed with autism spectrum disorder (ASD). Children with ASD have trouble recognizing emotions from facial expressions,[11-13] tone of voice, body language, and situation contexts.[14-17] The meta-analysis study reveals that impairments in facial affect recognition are associated with autism spectrum disorders.[18] Another study showed that there was a relationship between executive functions and sensory processing with emotional recognition in autism spectrum disorder.[19] ER may increase in older adults than in younger ASD.[20] ER modulation causes repeated behavior, social isolation, and peer rejection. ER may impact episodic memory, social interaction, vocational performance, and mental comorbidity.[21,22] Due to emotional dysregulation, most ASD individuals have shown obsessive behavior, self-injury behavior, irritability, aggression, screaming, mood swings, temper tantrums, poor anger control, maladaptive behavior, avoidance, escaping, and crying.[23,24] The study showed maladaptive behavior may lead to impaired school functioning, which could affect the long-term outcome.[25] Individuals must learn to control their emotional arousal via cognition capabilities and appropriately respond in a social context.[26]

Emotional arousal control and ER (affective/cognitive empathy) work together as brain-mind functions for human wellness.[27] Studies have stated that emotional arousal (low) control and ER (affective empathy, such as attention, working memory, episodic memory) are linked to self-awareness and awareness of others.[28,29] Previous literature has also reported that people with ASD have impaired attention, working memory, and episodic memory due to preserved rote memory and reduced use of organizational strategies to support recall. Additionally, the study showed a correlation between facial recognition, sensory perception, attention, and memory.[30]

Hyper-emotional arousal in ASD children causes emotional dysregulation and cognitive impairment.[31] Emotional arousal governs both positive and negative reactions and is more associated with ER memory.[32,33] Emotion recognition memory (ERM) is the feeling of personal experience in everyday life. For example, a person (i.e., joyful, stressful), a place (i.e., safe, threatening), and everyday activities (i.e., fun, exciting, challenging, or dull).[34] ERM has a significant role in everyday functioning for children, but it is affected by ASD. ERM allows an individual to favorably or adversely understand people's emotions, places, and activities. When ERM is impaired, a child may not try to know a person (self and others), places, and activities.[35] Occupational therapists and parents may help children with ASD participate in daily activities by knowing ERM. ERM is also linked to visual working memory, spatial memory, future thinking, mentalizing/ theory of mind (ToM), cognitive flexibility, planning, prospective memory (event-based and time-based), and social cognition.[20,28,35-38]

Numerous interventions for ASD have been proposed; however, most current research data are lacking to support their effectiveness in emotion recognition in generalization. A few ER interventions have improved emotion expression, but not in real clinical settings. For example, using animated vehicles with real emotional faces, 'reading the mind in films, and reading the mind in the voice test.[14-16] A systematic review of ER treatment and generalizability among people with ASD. They identified 13 randomized control trial (RCT) studies with cohorts aged 4 to 18 with an IQ >70. The outcomes and treatments reported in the reviewed studies were profoundly different, and many of the studies showed that the training effectively improved the participants' ER. However, all the ER treatments were conducted using computed-based programs, not in real-world clinical settings. Consequently, it was concluded that the findings were unclear and, thus, they cannot be generalized.[39]

Self-relaxation (mindfulness) is regulated by a person's conscious mind and the flow of emotions and thoughts in the mind and body.[40] Few studies have reported that mindful body training modulates functional neural connectivity and improves memory function in children with ASD.[41,42] Another study found that music regulates emotion recognition memory for social cognition in children with ASD.[43] Treatment using mellow, rhythm-based music with a slow tempo (60 beats per minute) regulates the appropriate emotions and reduces aggressive and repetitive behavior in ASD.[44] Therefore, applying mellow music, mindfulness relaxation (deep breathing), and mind-body exercises (slow body movement) enhances low emotional arousal, thereby supporting empathy.[45-47]

Previous studies have found that children with ASD are affected by the underlying components of emotion and cognition. Consequently, this may affect the essential problems these children face in relation to social interaction, communication, and repetitive/ interest behavior. However, no studies have developed an intervention strategy for synchronizing emotion control (low arousal) and ER (affective empathy and cognitive empathy of attention, working memory, and episodic memory) for social cognition among people with ASD. Emotional regulation and cognitive function are closely related to social cognition for social interaction. Therefore, the current study was to develop underlying components for ASD children and parents' well-being using the occupational therapy frame of reference of cognitive behavior therapy,[48] the dynamic interaction model (DIM),[49] and Empathic Systemic (E-S) theory.[50] E-S theory addresses both systemizing and empathizing with ER in ASD. Systemizing is the drive to analyze or form a system. There are many systems to analyze in humans, such as natural, mechanical, numerical, collectible, motor, sensory, spatial, social, music, action sequence, environmental, and vocal/ auditory/verbal. While every person has specialized skills in any one system, children with ASD are more obsessed with some specific systems; for example, spinning wheels or objects and stereotypical movements are desirable to children with ASD. The males were better at systemizing (logically) than empathizing. For example, males are better at working with motor tasks or concepts (tools, computers, handling phones, and car mechanics). However, females are better at empathizing (emotionally) than systemizing. For example, females are particularly good at caring for others. They are well-socialized, understand other people's feelings, and are good at helping others. Thus, while ASD affects both systemizing and empathizing, the degree to which it does so varies with gender.[50]

The proposed study incorporates E-S theory by integrating an emotion and cognition intervention using computer-based or multimedia formats. The combined method of CBT breathing techniques and mind-body exercises (simple body movements) with mellow instrumental music is used for processing emotional arousal skills. DIM is used to help integrate the underlying cognitive process for emotion recognition memory to enhance social cognitive performance among children with ASD.[51.52] As a result, the present study required the development of a training program to identify emotional states in the memory of children aged 5 to 10 years. The development of emotional recognition occurs within this particular age range (5 to 10 years).

In phases 1 and 2, the study aimed to construct the theoretical conceptualization framework of the emotional recognition memory training program (ERMTP) and examine the content validity. In phase 3, the pilot test evaluated the ERMTP feasibility of typically developing children. Moreover, the study explores the typically developing children and their parent's feedback about the ERMTP. Finally, the study also evaluated the preliminary efficacy of ERMTP on emotion regulation, memory, and social cognition among ASD.

Materials and methods

The current research is divided into three phases. Phase one described the theoretical conceptualizations of the development of the emotion recognition memory training program (ERMTP). The expert review of the content validity of the generated ERMTP is presented in phase two. The pilot study was done in the third phase to explore the viability of the ERMTP on five typical developing children and the preliminary efficacy of ERMTP in ASD. The following are the specifics of the process in three steps.

Phase 1. *Theoretical conceptualization of ERMTP development*

The Development of the ERMTP for social cognitive skills among children with ASD was based on the theoretical literature review. The framework was developed with the age range of 5 to 10 years. Hyper emotional arousal and emotional recognition memory (ERM) deficits have significantly affected the development of social cognition in children with ASD.[53] Dysregulation of emotional arousal may also be influenced by hyperresponsivity to environmental (e.g., loud background noise) and sensory stimuli (e.g., visual and auditory), with the sensory stress acting as emotional triggers.[54,55]

The cognitive-behavioral frame of reference (FOR) is primarily used in occupational therapy to understand better a person's needs with emotional and mental disturbance.[56] It has five components: emotion, thought, behavior, response, and environment. These individual components are integrated and function meaningfully in a social context. One of the critical elements in cognitive behavioral therapy (CBT) is the hierarchical levels of cognition. Occupational therapists use this conceptualization to understand the problems faced by ASD based on the children's emotions, thinking process, physiological response, behaviors, and environment. Children with ASD have an emotional empathy imbalance that may lead to cognitive disturbance.[57] Autistic children have emotion dysregulation but intact emotions. They can show their feelings (emotions) by themself, such as enjoyment, pleasure, and joy. Adults with ASD have a stress level ranging from 25% to 55%; 42-84% experience anxiety, 30–56% experience physical violence, 30-50% experience depression, and 40% suffer from chronic unhappiness.[58,59] The cognitive-behavioral frame of reference (FOR) is a more unified approach in occupational therapy rather than only using CBT (i.e., deep breathing) for stress and anger management for people with ASD. Especially relaxation technique of deep breathing is a preparation method used for the emotion regulation impairment of ASD.[48] Deep breathing is a useful method for calming down emotion. Children with ASD often get angry and frustrated. Therefore, deep breaths with a relaxing period and positive reinforcement (classic conditioning) may be helpful to the children.[60] A study that reviewed CBT (deep breathing/ relaxation) and mind-body movement with listening to rhythmic mellow instrumental music showed that there

is an association between changes in the cortical area for emotion regulation in children with ASD.[51,52,60]

The proposed ERMTP (figure 2) was developed based on a review of previous articles. It consists of a combination of several techniques available from CBT approaches,[56] E-S theory,[50,52] information processing model of cognition,[61] working memory model,[62] and the DIM (computer-based memory recognition training),[63] and as well as newly formed material. Therefore, two activities of deep breathing and slow body movement with rhythmic mellow instrumental music are recommended to reduce emotional hyperarousal. According to the information processing model of cognition[61] and working memory model,[62] which requires nine activities related to underlying components of sensory reception-perceptual memory, selective/sustained attention, working memory storage (visual/auditory), and episodic memory to improve emotion recognition. The ERM of six basic facial emotional expressions (happy, sad, angry, fearful, disgusted, and surprised) improved social cognition via computer-based training.[50,63] The ERMTP components consist of Task 1 (two activities) and Task 2 (nine activities).

Phase 2. *Expert evaluation method*

An expert panel evaluated the procedures utilized to assess the produced ERMTP's content validity. Five professionals received the initial draft of the intervention tool that had been created. An occupational therapist, a teacher, a special educator, a pediatrician, and a clinical psychologist were among the professionals who took part in this investigation for the construct of emotional recognition memory performance. All five professionals had master's degrees and five years of clinical experience in the field of children with ASD. The teacher worked in a school with children ranging in age from 5 to 10 years old.

Each assessment tool item was given a score on a scale of clear (+1), uncertain (0), or unclear (-1) by the five experts. The rating for each item's Item Objective Congruence (IOC) index was determined. The IOC values between 0.5 and 1 were considered acceptable.[64,65] Following that, all intervention program tasks were updated following the specialists' suggestions. Following any advice from the experts, the researchers revised the intervention program. Finally, pilot research with a sample group of 5 typically developing children evaluated the feasibility of the intervention for children with ASD. The training program was approved as a result of the pilot study's findings. To determine whether the intervention is suitable for ASD based on its viability in typical developing children. Furthermore, the study controls the ceiling effect by observing the typical developing children, who experience all six emotions independently without any prompts.

Phase 3. *Pilot testing*

Participants

The pilot study was conducted to investigate the feasibility of the ERMTP on five typically developing children. Institutional review board (IRB) approval (IRB/2176/22, ICT21R/010/03) granted by the Research Ethics Committees of the King Abdullah International Medical Research Center (KAIMRC), Saudi Arabia. The parent's written consent form was obtained, and the research procedure and methodologies were thoroughly explained to the participants.

Typical developing children

The study included the typical developing children in the age range of 5 to 10. The five children were collected from the Riyadh, Saudi Arabia International School. Children who are able to speak and comprehend English were involved in the research. Children with normal eyesight and hearing were included in the study. The study did not include any children who received memory training or supplements. The children who had medical diagnoses in the past are not included in the study.

Children with ASD

The children with ASD (age range 5 to 10) were collected from the clinical center of ASD. Based on a licensed psychiatrist report, all five children with mild-to-moderate ASD were included. The study included participants who could follow simple verbal directions and instructions. Their IQ ranged from 69 to 83 (borderline) according to the clinical psychological report of the Wechsler Intelligence Scale for Children–Fourth Edition.[66] Furthermore, the children must sufficiently understand spoken English to comprehend the testing procedures.

Instruments

The study examined the effect ERMTP effects on emotion regulation, memory, and social cognition among ASD by using the following measures. All outcome measures were completed at pre-intervention and post-intervention time points only. Emotional regulation was evaluated using the Childhood Autism Rating Scale (CARS) with two domains: imitation and emotional response.[67] All scale subtests were reliable and valid. The Children Memory Questionnaire-Revised and the Observation Memory Questionnaire-Parent Form (OMQ-PF) were used to measure the emotion recognition memory.[68,69] The OMQ-PF was internally consistent and positively linked with learning. The Social Responsiveness Scale, Second Edition was used to assess social cognition. All four outcome measures have good reliability and validity.[70] In addition, measures to track pilot study protocol adherence.

Data collection procedure

Five children with typical development and five children with ASD completed two activities in Task I and nine activities in Task II (Table 1). The children were instructed to remain upright with their bodies and legs crossed on the floor to complete Task 1. The children were seated in a serene area with adequate ventilation and illumination. Every child participated in two activities. The children were then instructed to position themselves progressively in front of the computer for Task II. When setting the 15.7-inch laptop monitor screen, the child's

60-centimeter visual field was considered. Using an adjustable chair and a footstool for proper seating, the chair is positioned at the appropriate height in relation to the workstation. The illumination was adequate and free of reflections on the computer screen. With the children, eleven varied activities were conducted. Each child practiced the ERMTP for 10 minutes of self-relaxation (deep breathing), 10 minutes of gradual body movements accompanied by soothing instrumental music, and then six basic emotion expressions (Figure 1-6) for 40 minutes. The intervention consisted of 14 appointments, each of which lasted 60 minutes and occurred seven times per week for two weeks.[62-64] The study measured the training average timing for two weeks for each child. After the session, the child and parents were asked for feedback and suggestions about the training. The study aimed to determine whether the typical developing children encountered any difficulties during the session. For ASD, outcome measures were conducted at pretest, treatment (14 sessions), and posttest.

Table 1 Emotional Recognition Memory Training Program (ERMTP).

Tasks	Domains	Activities
Task one (2 activities)	**Emphasizing/emotional component** (Sharing of emotional expressions with others & regulation of low emotion arousal)	1. **Cognitive behavior therapy (10 mins):** - Fourteen slow, deep breathing counts with rhythmic mellow instrumental listening music. 2. **Mind-body exercise (10 mins):** - Ten slow, simple bodily movements (1 to 3 count) with rhythmic mellow instrumental listening music. 1. Neck: bend (flex) and straight (extend) 2. Face: eyebrow-raising, opening/closing mouth, lip smiling/blowing. 3. Eye gaze: closing/opening eye, up, down, inward, outward, rotation movement. 4. Shoulder: up and down 5. Elbow: bend (flex) and straight (extend) 6. Wrist: bend (flex) and straight (extend) 7. Finger: close and open 8. Knee: bend (flex) and straight (extend) 9. Ankle: bend (flex) and straight (extend) 10. Body: bend (flex) and straight (extend)
Task two (9 activities) 1	**Systemizing/cognitive component** (Understanding others' emotions: Theory of mind) Visual-auditory reception and perception of emotional face recognition	**Computer-based training:** - The child is instructed to silently watch and listen carefully to six different (happy face, sad face, angry face, fearful face, disgusted face, and surprised face) emotional visual-auditory pictures of human facial expressions (30 secs for each slide).
2	Visual selective and sustained attention of emotional face recognition	**Computer-based training:** - The child is instructed to silently observe and focus on six pictures of human facial expressions depicting emotions (30 secs for each slide) and to discriminate the visual stimuli of the appropriate emotional response.
3	Visual Working memory (Short term memory) storage of emotional face recognition	**Computer-based training:** - The child is instructed to recall and express the six facial expressions in the slide show. - The child may express either verbally (telling) or non-verbally (motor action, pointing in flashcards).
4	Auditory selective and sustained attention of emotional face recognition	**Computer-based training:** - The child is instructed to listen carefully and silently to six different human vocal emotion tones (i.e., happy, sad, anger, fear, disgusted, and surprise) in each slide (white screen) shown for a 30-second without being distracted. The slide shows how to apply different auditory stimuli of human sound to discriminate the appropriate emotional response.
5	Auditory Working memory storage of emotion face recognition	**Computer-based training:** - The child is instructed to recall six different vocal emotional tones. - The child may express verbally (telling) or non-verbally (motor action, pointing in flashcards).
6	Episodic memory of emotion face recognition	**Computer-based training** - The child is instructed to express the person's emotion, place, and event after watching the different context pictures in the slide show.
7	Self-emotion facial recognition memory (child)	**Real-world clinical setting:** - The child is instructed to express (verbally or non-verbally) their facial expression by looking in the mirror.
8	Other emotions facial recognition memory (therapist/ caretaker)	**Real-world clinical setting:** - The child is instructed to express (verbally or non-verbally) the therapist/caretaker's facial expressions by seeing them in the presented images.
9	Generalization	**Real-world clinical setting:** - The child is instructed to express other children's emotions by seeing and listening to their tone of voice and body language in the occupational therapy department.



Figure 1. *Smile expression.*



Figure 2. *Sad expression.*



Figure 3. *Anger expression.*



Figure 4. *Fear expression.*



Figure 5. *Disgust expression.*



Figure 6. *Suprise expression.*

Data analysis

1. The IOC Index was used to analyze the Content's validity. The IOC values below 0.5 are deemed unsatisfactory, but IOC values over 0.5 are considered acceptable.[71]

2. The initial pilot testing was conducted using descriptive analysis and Wilcoxon signed-rank test. The Wilcoxon signed-rank test was used to identify the statistically significant difference in pre and post-ERMTP intervention on emotion regulation, memory skill, and social cognition among ASD. The statistical significance was set at $p<0.05$.

Results

The item-objective congruence (IOC) test was used to assess the content validity of the ERMTP (Table 2). We used IOC indices for multidimensional items to determine if the eleven task items that comprised the intervention had content validity. This was done so that we could see if the intervention was beneficial or not. According to the findings, the ERMTP exhibited excellent levels of content validity in the different activity items, particularly regarding the clarity and relevance of the activities themselves. When looking at each intervention component separately, all five raters concluded that the IOC for the intervention as a whole was 1.0. Despite this, the experts provided some helpful recommendations concerning the generalization of information, the use of flash card pictures, the addition of calming music, the addition of background voice in task 1 (activity 1 and 2), and the timing of each assignment. The ERMTP was finally modified due to the recommendations given by the experts, which led to a higher degree of content validity as a direct result of these modifications.

Table 2 Index of Item-Objective Congruence (IOC) from the five experts of the survey for ERMTP.

Activity Items in terms of clarity	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Item Objective Congruence (IOC)
1. The objective of the training is stated clearly.	+1	+1	+1	+1	+1	+5/+ 5= +1 (Acceptable)
2. The purpose of every task activity item is clear.	+1	+1	+1	+1	+1	+5/+ 5= +1 (Acceptable)
3. The task activity item is appropriate.	+1	+1	+1	+1	+1	+5/+ 5= +1 (Acceptable)
4. The instruction is clear.	+1	+1	+1	+1	+1	+5/+ 5= +1 (Acceptable)
Activity Items in terms of relevancy	**Expert 1**	**Expert 2**	**Expert 3**	**Expert 4**	**Expert 5**	**Item Objective Congruence (IOC)**
Task 1: 1. Cognitive behavior therapy - Deep breathing with mellow music (10 mins).	+1	+1	+1	+1	+1	+5/+ 5= +1 (Acceptable)
2. Mind-body exercise - Slow body movements with mellow music (10 mins).	+1	+1	+1	+1	+1	+5/+ 5= +1 (Acceptable)
Task 2: 1. Visual-auditory reception and perception of emotional face recognition	+1	+1	+1	+1	+1	+5/+ 5= +1 (Acceptable)
2. Visual selective and sustained attention of emotion face recognition.	+1	+1	+1	+1	+1	+5/+ 5= +1 (Acceptable)
3. Visual Working memory storage of emotion face recognition.	+1	+1	+1	+1	+1	+5/+ 5= +1 (Acceptable)
4. Auditory selective and sustained attention of emotion face recognition.	+1	+1	+1	+1	+1	+5/+ 5= +1 (Acceptable)
5. Auditory Working memory. Storage of emotion face recognition.	+1	+1	+1	+1	+1	+5/+ 5= +1 (Acceptable)
6. Episodic memory of emotion face recognition.	+1	+1	+1	+1	+1	+5/+ 5= +1 (Acceptable)
7. Self-emotion facial recognition memory (child)	+1	+1	+1	+1	+1	+5/+ 5= +1 (Acceptable)
8. Others' emotional facial recognition memory (therapist/ caretaker).	+1	+1	+1	+1	+1	+5/+ 5= +1 (Acceptable)
9. Generalization	+1	+1	+1	+1	+1	+5/+ 5= +1 (Acceptable)

Table 3 shows the characteristics of participants of typical developing children and ASD in the study. There were four girls and one boy in the age range of six to eight years old in typical developing children. Two students were enrolled in Grade 1 and three in Grade 2 in regular school. There were five children with ASD children aged 6 to 8 years old (Mean; SD =6.8; 0.836). Two children with ASD had mild symptoms, whereas three had moderate symptoms.

Table 3 Characteristics of typical developing children's (N=5) and children with ASD (N=5).

Participant characteristics of typical developing children's	Girls (%)	Boys (%)	Total (%)
Age 6	1 (50.0%)	1(50.0%)	2 (100.0%)
Age 7	1 (100.0%)	0 (0.0%)	1(100.0%)
Age 8	2 (100.0%)	0 (0.0%)	2 (100.0%)
Regular school - Grade 1	1(50.0%)	1(50.0%)	2 (100.0%)
Regular school - Grade 2	3 (100.0%)	0 (0.0%)	3 (100.0%)
Participant characteristics of ASD			
Age 6	2 (100.0%)	0 (0.0%)	2 (100.0%)
Age 7	0 (0.0%)	2 (100.0%)	2(100.0%)
Age 8	0 (0.0%)	1 (100.0%)	1 (100.0%)
Diagnosis Mild ASD	1 (50.0%)	1 (50.0%)	2 (100.0%)
Diagnosis Moderate ASD	1 (25.0 %)	2 (75.0%)	3 (100.0%)

An analysis of the use concerning difficulty with the ERMTP is shown in Table 4. All five children could follow all of the emotional expressions and tasks. One child attended the 10 days of instruction, while the other four participated for the full 14 days. The teaching took an average of 54 minutes for Child 1, 50 minutes for Child 2, 45 minutes for Child 3, 56 minutes for Child 4, and 42 minutes for Child 5. The therapy session was described as engaging, joyful, enjoyable, growing in concentration ability, and calming, and Child 5 proposed adding extra timing for memory recall tasks. Additionally, following ERMTP, the parents of all 5 children reported that their children's concentration, relaxation, and memory skills had improved. For example, one parent said, "My child brings the pencil box without fail in the classroom and pays more attention to the daily task skill of dressing and brushing." One parent reports that her child obeys their instructions more easily than before.

Table 4 Results of the use concerning difficulty with the ERMTP.

N	Gender (Years, month)	Difficulty in using the ERMTP		Number of training session days	Two-week training average	Child feedback & suggestion
		Able to follow emotional expressions & instructions	Not able to follow emotional expressions & instructions			
1	Female (6 years 9 months)	Yes	-	14/14	54 mins	Interesting and happy
2	Female (7 years 6 months)	Yes	-	14/14	50 mins	Fun and enjoying
3	Female (8 years 2 months)	Yes	-	14/14	45mins	Increasing focusing skill
4	Male (6 years 4 months)	Yes	-	10/14	56 mins	Fun game
5	Female (8 years 4 months)	Yes	-	14/14	42 mins	Relaxing and the child suggested to increase the timing for recall memory task

Table 5 compares pre- and post-ERMTP intervention for ASD (N=5). Emotional response and imitation were the two subdomains used by CARS to evaluate emotional regulation. A statistically significant difference was found in both imitation (Z=-2.070, p=0.038) and emotional response (Z=-2.121, p=0.034). CMQ-R and OMQ-PF were used to measure the emotion recognition memory. A statistically significant difference showed in CMQ-R total score (Z=-2.023, p=0.043) and subdomains of episodic memory (Z=-2.032, p=0.042), visual memory (Z=-2.033, p=0.043), and working memory (Z=-2.032, p=0.042) was found. Furthermore, the total score of the Observation Memory Questionnaire- parent form (Z=-2.033, p=0.043) revealed a statistically significant difference. The social responsiveness scale was used to assess social cognition. Social awareness (Z=-2.060, p=0.039), social motivation (Z=-2.032, p=0.042), restricted interests and repetitive behavior (Z=-2.033, p=0.043), social cognitive index (Z=-2.033, p=0.043), and total score (Z=-2.032, p=0.042) were all statistically significant. Social cognition (Z=-1.769, p=0.077) and social communication (Z=-1.604, p=0.109) showed no statistically significant differences.

Table 5 Comparison of pre-and post-ERMIP intervention for ASD.

Measures	Pre-intervention	Post-intervention	95% confidence interval		Z	*p*
	Median (min, max)	Median (min, max)	Lower	Upper		
CARS: Imitation	3 (2.5, 3.0)	2 (2.0, 2.5)	0.068	0.032	-2.070[b]	0.038*
CARS: Emotional response	3 (2.3, 3.0)	2.5 (2.0, 2.5)	0.064	0.032	-2.121[b]	0.034*
CMQ-R: Episodic memory	33 (46,162)	42 (48, 204)	0.068	0.033	-2.032[d]	0.042*
CMQ-R: Visual memory	15 (12, 26)	25 (20, 35)	0.067	0.031	-2.023[d]	0.043*
CMQ-R: Working memory	29 (12, 36)	36 (25, 45)	0.068	0.033	-2.032[d]	0.042*
CMQ-R: Total score	81 (42, 108)	95 (81, 126)	0.062	0.030	-2.023[d]	0.043*
OMQ-PF Total score	73 (70, 103)	92 (87, 110)	0.068	0.033	-2.023[b]	0.043*
SRS: Social awareness	72 (68, 74)	63 (61, 65)	0.061	0.071	-2.060[b]	0.039*
SRS: Social cognition	68 (60, 76)	63 (54, 70)	0.115	0.128	-1.769[b]	0.077
SRS: Social communication	76 (72, 77)	74 (70, 76)	0.240	0.257	-1.604[b]	0.109
SRS: Social motivation	65 (62, 67)	64 (56, 64)	0.057	0.067	-2.032[b]	0.042*
SRS: Restricted interests and repetitive behavior	68 (62, 73)	65 (60, 67)	0.060	0.069	-2.041[b]	0.041*
SRS: Social cognitive index	73 (68, 75)	65 (59, 72)	0.058	0.068	-2.023[b]	0.043*
SRS: Total score	75 (67, 80)	70 (63, 76)	0.062	0.028	-2.032[b]	0.042*

*Note: CARS: childhood autism rating scale, CMQ-R: children memory questionnaire-revised, OMQ-PF: observation memory questionnaire-parent from, SRS: social responsiveness scale, Wilcoxon singed ranks test, *significant at p<0.05*

Discussion

We developed a theoretical framework for the ERMT program to enhance social cognition in children with autism spectrum disorder (ASD). The previous studies of emotion recognition intervention programs do not include real-world clinical settings.[39] Nevertheless, no research has developed an intervention strategy that synchronizes ER (affective empathy and cognitive empathy of attention, working memory, and episodic memory) and emotion recognition (low arousal) for social cognition in individuals with ASD. The study present study developed the ERMTP components consisting of Task 1 (two activities) and Task 2 (nine activities).

In the second phase, we analyzed the content validity of the ERMTP. Five subject matter experts assessed the validity of ERMTP's material. The highest score possible was awarded to each of the five experts and recommendations.[65] All five experts were given +1, and due to emotion pictures were developed in accordance with age-specific standards. During the training program, we were responsible for following the instructor's directions regarding the generalization work and the background music or voice. In the end, the modification was approved by all five of the specialists, and it was incorporated into the most recent version of the ERMTP for children.

In the third phase, we conducted pilot testing with children whose development was normal. The breakdown of the issue discovered during the pilot test of the ERMTP can be found in Table 4, which explains the problem. The five children had no problem comprehending any of the actions that were taking place or the facial expressions that were being employed. There was a total of five children who took part in the training session that lasted for fourteen days, while there was only one child who took part in the session that lasted for ten days. The ERMTP timing ranged from a minimum of 42 minutes to a maximum of 56 minutes, and all five children finished it. On average, the total amount of time (duration) spent on each activity by each of the five children was 49.4 minutes. Early studies supported measuring the duration of outcomes across treatment domains for children with autism spectrum disorder.[71] Child number 5 proposed including a more extended period within the recall memory task. Only two weeks' worth of training (14 total sessions) was applied to the children. According to studies conducted in the past, a successful intervention should occur six times per week for four weeks, with sessions lasting either 24 or 60 minutes.[62-64] We only provided training for two weeks training (14 sessions). In further research, we plan to lengthen the period to sixty minutes.

All five children commented that the treatment session was interesting and fun and included an enjoyable game. In addition, they reported feeling more relaxed and having an increased capacity for focused attention. Moreover, the ERMTP resulted in favorable comments and suggestions from the children's parents regarding changes in their abilities to relax and enhance their memory. These results may be attributed to the ERMTP. The training program was described as straightforward in its instructions and useful by all five children and their parents. On the other hand, the children maintained their attention and motivation for the entirety of the session.

Table 5 showed the analysis of the ASD treatment received during and after ERMTP. The emotional regulation was measured using the two subdomains of the CARS. ERMTP demonstrated improvements in the imitation and emotional response subdomains. Early studies also supported the idea that emotional regulation was improved by providing emotion recognition training.[63,64] The emotion recognition memory was evaluated using two outcome measures, the CMQ-R and the OMQ-PF. The CMQ-R total score and subdomains of episodic memory, visual memory, and working memory revealed a statistically significant difference between pre- and post-ERMTP treatment. Furthermore, the total score of the Observation Memory Questionnaire-Parent form showed a statistically significant difference in ERMTP. The current study identified the underlying components of emotion recognition memory based on previous research, and training was given accordingly.[41,53] As a result, children with ASD improved their memory domains. Finally, social cognition showed a statistically significant difference in social awareness, social motivation, restricted interests, repetitive behavior, social cognitive index, and total score of SRS. However, social cognition and social communication did not improve after ERMTP was implemented. This could be because the intervention was applied for a shorter period. The current pilot study only employed an intervention period of two weeks. Previous research has demonstrated that the minimum number of weekly sessions should be three to sixteen weeks.[63,64,71] Overall, the pilot study found that ERMTP affected emotion regulation, memory, and social cognition in children with ASD.

Limitations and future recommendations

The pilot study only lasted two weeks for the intervention training. The duration should be increased to four weeks in subsequent research, and randomized controlled trials with both children with ASD and other atypical developing children should be conducted. Furthermore, the sample size that was used was not very large. The researcher did not have control over the biases in the parent report since the parent was already aware that the children had achieved the program's goal.

Conclusion

The ERMTP improves the emotion recognition and social involvement of children with ASD by teaching the six facial expressions using technology and real-world clinical settings. According to parent reports of typically developing children from the pilot study, taking ERMTP for two weeks can increase a child's ability to pay attention and short-term memory. When we conduct future studies, we must use RCT methods and lengthen the period children with ASD are treated.

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Conflict of interest

The authors reported no potential conflict of interest.

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