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Research Article

Effects of an Interactive Multimedia Computer Program on the Facial Emotions Processing and Social Adaptation in Adults with ASD

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Abstract

This study examined effects of the Interactive Emotional Enhancement Training (IEET) computer-based program on basic emotion recognition and social competence in a group of adults with autism spectrum disorders (ASD) (n = 42) with a mean age 32.98 +/- 6.19 years. A preliminary pre-test, post-test randomized control group experimental design was used to measure effects of a 36-week IEET program consisting of 410 activities. The IEET program uses instructional computer-based activities delivered during 144 1-hour sessions (5 hours/week). Results demonstrated that participants who received the intervention improved their emotion recognition skills, as well as their social competence. The current results suggest that the IEET program may represent an efficient and cost-effective strategy for teaching emotion recognition to adults with ASD.

INTRODUCTION

Autism spectrum disorders (ASD) are estimated to affect 1 in 68 children; boys are five times more likely than girls to carry the diagnosis [1]. Emotion recognition is a critical part of the social communication and interaction deficit associated with ASD [2,3]. In this research, emotion recognition is defined as the ability to discriminate an emotion from observing a facial expression. Emotion recognition has been closely linked to socio-emotional skills and social competence [4]. Although, there have been limited efforts to improve socio-emotional cognitive abilities of people with ASD [5], in the last decade several training programs have been developed to address challenges with facial emotion recognition [6,7]. These specialized interventions are often challenging to administer with adults with ASD because of the extensive staff commitment and resources required for administration. However, computerized educational programs may provide one method to help adults with ASD learn social and emotional skillssuch as social competence, social interaction, recognition of emotions in faces and voices, etc. [8-9]. Although the effectiveness of computerized educational programs has been demonstrated to promote language and vocabulary acquisition for people with ASD [10], research is needed that examines the use of computer programs to teach complex social-emotional skills [11].A few computer programs designed to teach complex social and emotional skills have recently been developed and tested with people with ASD (for a review, [6,7]). For example, Bolte et al. [12], demonstrated the usefulness of a computer program to assess and teach adults with ASD to recognize facial affect. The objective of this program was to diagnose problems with social-communicative skills and support skill development focused on elementary emotion perception and interpretation; however, results failed to indicate meaningful improvements in social and cognitive skills, and generalization was not established.Silver and Oakes [13] examined effects of a computer program designed to teach people with ASD to better recognize and predict emotional responses in others; the researchers demonstrated that those in the experimental group improved their emotional processing skills and these skills were generalized. Gains correlated significantly with the number of times the computer program was used.In addition, in a randomized clinical trial, Tanaka et al.[14], implemented a computerized program “Let’s Face It!” with a group of people with ASD. Although participants demonstrated positive improvements in their analytic recognition of basic facial emotions (except the angry expression), they did not demonstrate an ability to generalize facial emotions across

different identities and showed a tendency to recognize the mouth feature holistically and the eyes as isolated parts.Golan and Baron-Cohen [15] evaluated "Mind Reading," an interactive multimedia program that teaches emotions and mental states using video, audio, and written text to systematically introduce basic and complex emotions; these researchers found that the group with ASD performed better than controls on emotion recognition from faces and voices and on 12 of 20 specific emotions. However, there was limited support for generalization of these skills to real-life contexts. Lacava et al.[16], also used the "Mind Reading" program to teach emotion recognition to students with ASD and reported that students improved on face and voice emotion recognition for basic and complex emotions taught via the software. However, there was limited support for generalization of these skills to real-life contexts. In the same manner, Golan et al. [17], examined effects of "The Transporters," an animated series using trains with faces that interact in social scenarios, emotion recognition on people with ASD; however, there was limited generalization to real-life situations.

Overall, these reviewed programs have several advantages, but also limitations. Among the advantages, we can include utilization of dynamic faces rather than static images and use of human faces in many programs, although some used cartoons or avatars instead. The more important limitations are that most of the programs are intended for children and adolescents, not for adults,tasks are limited to a short period of training, there are no scheduled follow-up activities (learning decays within a few weeks), andthere were no generalization of effects to real-life circumstances.

In summary, although there have been initial attempts to teach individuals with ASD emotion recognition, few studies have demonstrated generalization to real-life situations and only research by Golan and Baron-Cohen [15] and Bolte et al. [12], examined effects on adults. Also, many of these programs relied on computer-based interventions that provided repeated exposure to whole-face pictures of emotions. The IEET program was developed to address the specific needs of adults with ASD and provides a psychological-based educational program using e-learning methodology that aims to improve emotion recognition skills. The IEET is a multi-media program what combines multiple elements (e.g., audio, video, graphics, text, animation) in an interactive form allowing the user to typically control the environment via the computer. The IEET was created to address some of the challenges reported in previous research and to have a program available in Spanish. As a result of the limitations of the aforementioned studies, the aim of this study was to examine effects of the IEET program on emotion recognition skills of individuals with ASD. Thepurpose of this study was to examine effects of the Interactive Emotional Enhancement Training (IEET) [18] on emotion recognition skills of adults with ASD. The main hypothesis was that the experimental group would perform significantly better on the emotion recognition post-test and social-competence post-test compared to the pre-test.

MATERIALS AND METHODS

Participants

Participants diagnosed with ASD who met DSM-IV (American Psychiatric Association) were recruited from a facility serving people with ASD located in Madrid, Spain consisting of individual homes under 24-hour supervision providing medical, educational, nursing, and mental health services. Participants were matchedon demographic variables (e.g., age, gender, severity of disability) and randomly assigned by a clinician blind to study objectives to either an intervention group or a wait-list group. A simple randomization with 1:1 allocation ratio was used. Participants were assigned using a computer-generated list of random numbers. A measure of non-verbal IQ was used (Test of Leiter) since most participants had limited spoken language. The intervention group included 21 adults (15 males and 6 females), ages (M = 33.33; Sd = 6.87) and the control group that included 21 adults (7 males and 14 females), ages (M = 33.61; Sd = 6.87) (Table 1). Participants were screened to exclude co-morbid psychiatric illness (e.g., schizophrenia, major depression) and neurological disorders that might influence brain functioning (e.g., epilepsy). Two participants were excluded because they had severe epilepsy with repeated daily seizures. Participants were evaluated pre/post intervention (9-months later) by therapists who were blind to study objectives. The therapists provide educative and clinical care to participants at the day center. The Ethics Commission of the institution approved the research project. An explanation of the study was given to participants, their tutors, and their families before the study were initiated. All participants or their guardians provided informed consent for participation in this study.

Design and Procedures

A pre-test, post-test control group experimental design was used to measure effects of the IEET, a computer-based, multimedia instructional program designed to facilitate the improvement of emotion recognition skills, on 21 adults diagnosed with ASD as compared to 21 adults with ASD who did not receive the intervention. In this report, pre- and post-treatment measures associated with emotion recognition are reported. The 21 participants completed all intervention sessions. Members of the control group were wait-listed and, subsequently, received the intervention at the end of this study. The screening of emotional processing deficits was evaluated a by Facial Discrimination Battery (FDB) described in the next paragraph.

Materials and Instruments

The Interactive Emotional Enhancement Training (IEET) [18].The IEET was developed based on the work of [18]. The differentiating feature of the IEET is its comprehensive nature. It includes didactic instruction, dynamic faces, allows for progress monitoring, therapist assistance, the support design for speed and progression, and directed attention to salient features. It is also appropriate for a broad age range of adults with ASD. Use of the program requires a computer, but no additional materials. The IEET is comprised of several components:

(a) Emotion Perception Training: Recognizing facial emotions from dynamic facial stimuli expressing emotions at different levels of intensities since these resemble the expression of emotions in daily life to a greater extent; recognizing facial emotions from schematic drawings; identifying emotions linked to situations; identifying emotions linked to desires; identifying

Table 1: Sample demographic and clinical characteristics.

		Intervention		Wait-List	
		Mean (SD)		Mean (SD)	
Test of Leiter (IQ)		58.90 (17.68)		57.15 (11.48)	$F_{(1.41)} = .14$; n.s
Chronological Age (in years)		33.33 (6.87)		32.61 (5.68)	$F_{(1.41)} = .13$; n.s
ASD-DA[1]		23.10 (5.11)		25.12(5.32)	$F_{(1.39)} = 1.56$; n.s
Sex (N)		21		21	
Males		15		7	$\chi^2 = .73$; n.s.
Females		6		14	

Note: 1) Autism Spectrum Disorders–Diagnosis for Adults (ASD-DA) [24]

Table 2: Descriptive statistics at Baseline and ANOVA.

Variable		Mean	Sd	Anova
FDB Emotion Tasks				
Matchingemotion	Wait-list	31.67	16.228	
	Intervention	34.00	18.610	$F_{(1, 40)} = 1.374$; n.s
Labeling emotion FDB Non-Emotion Tasks	Wait-list	63.62	14.564	
	Intervention	57.94	16.132	$F_{(1, 40)} = .184$; n.s
Matching identity	Wait-list	73.81	21.558	
	Intervention	66.19	23.125	$F_{(1, 40)} = 1.438$;n.s
Labeling Age	Wait-list	37.70	13.403	
	Intervention	35.52	13.151	$F_{(1, 40)} = 1.220$;n.s
VABS. Composite Score	Wait-lit	256.52	75.939	
	Intervention	229.52	73.303	$F_{(1, 40)} = .284$;n.s

Table 3: Descriptive statistics at Baseline and at Post-Intervention (10-months later) and ANCOVA.

		Baseline		Post-Intervention		ANCOVA	η^2
Variable	Condition	Mean	SD	Mean	SD		
FDB Emotion Tasks							
Matchingemotion	Wait-list	31.67	16.228	32.14	15.78	$F_{(1.34)} = 17.33$; p <.001	.34
	Intervention	34.00	18.610	44.24	9.96		
Labeling emotion	Wait-list	63.62	14.564	68.46	13.16	$F_{(1.34)} = 29.37$; p <.001	.46
	Intervention	57.94	16.132	85.33	7.91		
FDB Non-Emotion Tasks							
Matching identity	Wait-list	73.81	21.558	74.76	19.65	$F_{(1.34)} = .14$;n.s.	.04
	Intervention	66.19	23.125	67.09	22.84		
Labeling Age	Wait-list	37.70	13.403	37.73	13.33	$F_{(1.34)} = .63$; n.s.	.01
	Intervention	35.52	13.151	35.49	13.17		
VABS. Composite Score	Wait-list	256.52	75.939	266.19	52.05	$F_{(1.34)} = 10.90$;	
	Intervention	229.52	73.303	310.38	28.22	p <.002	.24

emotions linked to beliefs, and (b) Informational States Training: identifying that people have different opinions on the same theme; practicing simple and complex visual perspective; training the principle "seeing leads to knowing" [16,19]; predicting future actions on the basis of a person's knowledge; training true and false beliefs understanding; training eyes and emotional processing; and differentiating between environmental and emotional sounds. The IEET was administered in hour-long sessions for 36 weeks by four therapists. The program was conducted individually (1:1 therapist to participant ratio) due to difficulties encountered by participants when they used the computer. During each session, participants were given many opportunities to identify the correct emotional expression from a range of expressions and were encouraged to consider each component of the expression in their decision-making. Participants were instructed to select the emotional expression

they thought had the greatest likelihood of being correct as quickly and accurately as possible. Verbal feedback consisted of either "Correct!" "Incorrect" or "No response detected" responses. The tasks were different each session. All participants had demonstrated computer skills since they use the computers regularly associated with other center activities. The project director trained the therapists to use the IEET program during three sessions. The role of the therapist consisted of assisting participants by providing informative feedback and support. Facial Discrimination Battery-Spanish Version (FDB-S) [17,20]. The FDB-S was administered to participants at baseline and the post-intervention phase, at the end of week 36. The FDB consists of four emotion tasks and two non-emotion or control tasks [18, 21]. All FDB-S emotion items feature high-contrast black and white photographs of happy, sad, and neutral expressions portrayed by professional Caucasian actors of both sexes ranging in age from 20 to 75 years. A detailed description of the original set of stimuli is found in [19,22]. Items were created with the Microsoft Power Point program and presented on a computer monitor. The experimenter began the test after a few practice items to determine if the participant followed instructions. The test was paced by the participant's response speed. The tester scored the participant's responses as correct or incorrect and then converted the result into a percent correct score. Percent correct scores were computed for each subtest.

Emotion Labeling: This task consisted of 36 items or trials depicting 12 happy, 12 sad, and 12 neutral facial expressions featuring 18 male and 18 female actors. Each trial presented one face at a time (6.0´´x7.0´´; 15.3 cm x 17.8 cm). Participants were asked to tell the experimenter whether a given face looked happy, sad, or not happy and not sad. The experimenter began the test after a few practice items to determine if the participant followed the instructions.

Emotion Matching: This task consisted of 20 items, each showing a 1.5´´ x 2.5´´ (3.9 cm x 6.4 cm) sample face located at the center top of the monitor and five choices of equal size arranged in a row below. The experimenter pointed at the sample picture and asked,''Look at this person. How does this person feel? Now look at the five pictures below and point to the picture of the person down here that feels the same as the person up here.'' After a few practice items, the experimenter began the test. The first 10 items involved within-gender matching the second 10 items a cross-gender matching.

Age Labeling: Consisting of 24 faces (nine young, 10 middle-aged, and five old faces), featuring 12 male and 12 female actors. Each trial presented one face at a time (6.000 x 7.000; 15.3 cm x 17.8 cm). The participant had to classify the face into one of the three age groups. Before the actual test beganpractice, items were presented. The age-labeling task was previously used in several research studies with individuals with mental.

Identity Matching: This task consisted of 10 items that had the same display format as the Emotion Matching task with a sample face at the top and a row of five faces below. Participants were required to find the face that matched the sample face. Five items featured female actors and five had male actors.

Vineland Adaptive Behavior Scales (VABS): The VABS interview Edition [20,23] is a widely used instrument designed to measure the adaptive behavior of individuals and is provided with solid psychometric properties. In this study, a composite standard score wasused (M= 100; SD = 15) to assess social adaptation. VABS items have weighted ordinal rating options that follow a developmental sequence.

Autism Spectrum Disorders–Diagnosis for Adults (ASD-DA): The ASD-DA [24]is an instrument designed to diagnose adults with ASD and contains 31 items scored as either ''0'' for ''not different, no impairment'' or ''1'' for ''different, some impairment.'' The test is typically administered in approximately 10 min. The ASD-DA has adequate inter-rater and test–retest reliabilities. Internal consistency was excellent (Cronbach's a = .94) and factor analysis produced a three-factor solution that mirrors the three classes of core symptoms outlined in the DSM-IV-TR (i.e., impairment in socialization, communication, and restricted behavior) [25]. Belva et al. [26], investigated the validity of the ASD-DA when compared to the Pervasive Developmental Disorder (PDD)/Autism subscale of the Diagnostic Assessment for the Severely Handicapped-II (DASH-II) [27]. The total scores and subscale scores of the ASD-DA correlated at the p <.001 level with PDD/Autism subscale scores on the DASH-II. These findings suggest that the ASD-DA is a valid measure for assessing autistic symptoms in adults with IDs.

Leiter International Performance Scale (LIPS): The LIPS [28] is a non-verbal intelligence test designed for people ages 2-18 years, although it can be applied to all ages. No speech is required from the examiner or participant. The tasks are self-explanatory and, after an initial demonstration, the examiner does not need to interact with the participant. The LIPS is useful for testing people with ASD. The LIPS was scored according to the method outlined in the manual and was derived and adjusted as recommended by Leiter [28].

Statistical Analysis: An ANCOVA was performed to determine whether significant differences existed between participants enrolled in the intervention group compared to the wait-list group. A 2x2 ANCOVA was performed with an inter-subject independent variable with two level conditions (intervention and wait-list) and the post-intervention measures as dependent variables and pre-intervention measures as covariates. Analyses were performed by SPSS (v.22).

RESULTS

Pre-treatment Differences

A study of the homogeneity of the two groups related to demographic and clinical variables found no significant differences. As presented in (Table 1), participants in the intervention and wait-list conditions did not differ in their intellectual functioning (Leiter Test) ($F_{(1,41)}$ = .14; n.s.), their age ($F_{(1,41)}$ = .13; n.s.), and their gender (χ^2= .73; n.s.). Also, there were no significant differences in their severity of ASD evaluated by ASD-DA ($F_{(1,39)}$ = 1.53; n.s.); however, the level of severity of the psychopathology is high in both groups [25].

Group Differences

An ANCOVA was conducted to determine a statistically

significant difference between the intervention and wait-list conditions on dependent variables: FDB Emotion tasks (Matching emotion and Label emotion), FDB Non-Emotion tasks (Matching identity and Labeling Age), and social competence as measured by the VABS (Composite Score) controlling for the baseline results See Table (2).

There was a significant difference post intervention on matching emotion ($F_{(1.34)}$ = 17.33; p <.001; η^2 =.34) showing an overall increase of matching emotion at program termination. Also for labeling emotion, there was a significant difference ($F_{(1.34)}$ = 29.37; p <.001; η^2 =.46)) indicating a substantial improvement associated with knowledge of emotion. In addition, there was an significant increase for social competence as measured by the VABS ($F_{(1.34)}$ = 10.90; p <.002; η^2 =.24) see Table (3). As we predicted, there were no differences on the non-emotional tasks, matching identity ($F_{(1.34)}$ = .14; n.s.; η^2 =.04) and labeling age ($F_{(1.34)}$ = .63; n.s.; η^2 =.01).

DISCUSSION

The present study was designed to determine effects of the IEET program on emotion recognition and social competence of adults with ASD. A valuable finding that emerged from the results is that by practicing simulated activities addressing emotional cognition and facial recognition skills on a computer, participants improved the skill to recognize basic emotions such as fear, happiness, disgust, and sadness as evaluated by FBD-S, but this skill did not improve for the control group. Furthermore, as suggested by improvements in the VABS, participants in the intervention condition improved their social competence. The results are in line with those of previous research [29] that has obtained mixed results on the facial processing of people with ASD. Baumont et al. [30], investigated the validity of a multi-component social skills program for people with ASD. Results of this study indicated that when compared to a control group the experimental group showed greater progress in developing their social skills as reported by parent and teacher-reports

The results from this study are also consistent with those of Golan and Baron-Cohen [15] who used "Mind Reading" software to teaching individuals with high-functioning ASD to recognize emotions in voices and faces; although the participants improved significantly in their scores on several emotion tasks (e.g., emotional concepts recognition), they did not significantly generalize these tasks.Soon thereafter, LaCava et al. [30], used the "Mind Reading" software to teach four youth with ASD to recognize basic and complex emotions in computer presented stimuli and demonstrated a significant improvement from pre- to post-intervention in faces and voice emotions recognition; however, effects were not strong enough to determine that the software was superior to other approaches. Finally, Silver and Oakes [13]) compared the "Mind Reading" software with other technologies such as asking participants to identify emotions in cartoons and mental states occurring in stories. The authors compared results of the experimental and control group and observed large and significant effects with measures of identification of emotional and mental states; however, no significant differences were found in the facial expression naming measure. The IEET program may help adults with ASD learn skills that increase their social and emotional functioning. The most often cited programs for enhancing emotional comprehension, such as "The Emotion Trainer" [13] or "Mind Reading: The Interactive Guide to Emotions [31] was not developed for adults with ASD. The IEET program was designed specifically for Spanish-speaking adults with ASD and derived from the Mind Reading software, a well-known verified program providing emotional training to people with ASD. These results are particularly promising because they demonstrate that the IEET may improve social competence beyond what was directly targeted by the intervention. Findings of the present study support previous researchdemonstrating that this software improves teacher-observed social function and emotion-processing skills (2133-2234). Current results suggest that the IEET program may represent an efficient and cost-effective strategy for teaching emotion recognition to adults with ASD.

LIMITATIONS

A few noteworthy limitations to the present study are essential to note. This study focused onbasic emotions as evaluated by FDB-S. Future investigations should focus on more complex emotions. The small sample size makes it difficult to generalize results to the broader population of people with ASD; we recommend that future studies use a larger sample size. In addition, since the study lasted only nine months the degree to which observed effects were maintained over an extended period,was not assessed. Therefore, it would be helpful if future research increased the duration of follow-up data collection. The absence of concurrent validity of the IEET program is an important limitation and could influence generalization of effects. Another limitation associated with this study was that we did not attempt to directly compare the IEET programwith other classic methods that are not technology-based. This is an important area for future research.

CONCLUSION

As a conclusion, our results indicate that there is some evidence to support use of electronic programs such as IEET to enhance emotion recognition to increase emotion recognition and social competence. We believe that future research examining effects of this technology will contribute to enhancing the social and emotional competence of adults with ASD.

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