Research in Autism Spectrum Disorders 83 (2021) 101748

Contents lists available at ScienceDirect

Research in Autism Spectrum Disorders

journal homepage: www.elsevier.com/locate/rasd

Efficacy of a computer-assisted cognitive-behavior therapy program for treating youth with anxiety and co-occurring autism spectrum disorder: Camp Cope-A-Lot

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ARTICLE INFO

Number of reviews completed is 2

Keywords:
Autism spectrum
Anxiety disorder
Cognitive behavior therapy
Computer-assisted
Psychotherapy
ASD
Social anxiety
Social phobia
Social skills
Child therapy

ABSTRACT

Background: In a crossover design the current study describes the efficacy of a computer-assisted intervention program for youth with autism spectrum disorder (ASD) who also experience co-occurring anxiety.

Methods: The computer-assisted cognitive behavior therapy (CBT) program for treating anxiety, Camp Cope-A-Lot (CCAL) was compared to control intervention, another computer-assisted program, The Social Express (TSE), that does not employ CBT nor is targeted for the treatment of anxiety. TSE is designed to improve social skills in youth with ASD. Participants had a principal anxiety disorder and a current diagnosis of ASD. Participants received 12-sessions of CCAL or 12-sessions of TSE. Outcome measures were obtained at intake, upon completion of the first intervention of the trial and upon completion of the second intervention of the trial.

Results: CCAL was efficacious for treating anxiety. Participants who completed CCAL demonstrated significant and clinical reductions in anxiety when compared to participants who completed TSE. Both interventions, CCAL and TSE, resulted in some limited improvement in social skills.

Conclusions: The current study showed that anxiety symptoms in youth with ASD and co-occurring anxiety disorders can benefit from computer-assisted CBT employing CCAL. This expands previous literature employing computer-assisted CBT interventions in youth, and more specifically, youth with ASD.

1. Introduction

Multiple studies suggest there is substantial co-occurrence of Autism Spectrum Disorder (ASD) and anxiety disorders for both children and adolescents (de Bruin, Ferdinand, Meester, de Nijs, & Verheij, 2007; Gillott, Furniss, & Walter, 2001; Leyfer et al., 2006; Mattila et al., 2010; Zaboski & Storch, 2018). Over a third of children and adolescents with a diagnosis of ASD also meet clinical criteria for at least one co-occurring anxiety disorder (van Steensel, Bögels, & Perrin, 2011; Zaboski & Storch, 2018). Children with ASD, particularly children with High Functioning Autism (HFA), have higher levels of anxiety compared to typically developing children (Brereton, Tonge, & Einfeld, 2006; Gillott et al., 2001; Mattila et al., 2010; White, Oswald, Ollendick, & Scahill, 2009). Three reviews of the literature investigating the prevalence of anxiety in children and adolescents with ASD (MacNeil, Lopes, & Minnes, 2009; van

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https://doi.org/10.1016/j.rasd.2021.101748
Received 31 May 2020; Received in revised form 15 February 2021; Accepted 20 February 2021
Available online 2 March 2021
1750-9467/

Steensel et al., 2011; White et al., 2009), reported youth with ASD experienced increased levels of anxious symptomology that vary across types of anxiety (MacNeil et al., 2009; van Steensel et al., 2011; White et al., 2009). Particularly, social phobia has been reported as a commonly occurring anxiety disorder among youth with ASD (Chang, Quan, & Wood, 2012; McNally-Keehn, Lincoln, Brown, & Chavira, 2013).

CBT is arguably the most empirically supported behavior-based modality of intervention for treating child anxiety disorders (Albano & Kendall, 2002; Ollendick & King, 1998; Sukhodolsky, 2016). In addition CBT has been found to be effective in treating anxiety in children and adolescents with ASD (Storch et al., 2015; Vasa et al., 2014; Weston, Hodgekins, & Langdon, 2016 review.). The effectiveness of the 16-week face-to-face Coping Cat intervention (Kendall, 1994) to treat anxiety has been replicated in children of varying ethnicity, gender (Treadwell, Flannery-Schroeder, & Kendall, 1995) and culture (Barrett & Turner, 2001; Barrett, Dadds, & Rapee, 1996).

Computerized CBT can be effective in the treatment of depression and anxiety in adults (Richardson, Stallard, & Velleman, 2010). However, outcomes of using computerized CBT on children and adolescents are sparse, particularly for those suffering from anxiety disorders with co-occurring ASD. Camp Cope-A-Lot (CCAL), a computer-assisted CBT intervention for anxiety in children and adolescents was derived largely from Coping Cat, has demonstrated efficacy in a head to head trial relative to more traditional CBT and a more general computer facilitated support program in anxious youth (Khanna & Kendall, 2008, 2010). Computer facilitated psychoeducational training for other needs of children with ASD are now available. One such curriculum is The Social Express (TSE). The TSE is a computer assisted program assigned to teach social skills in children with ASD.

The primary goal of this research was to investigate the efficacy of a computer-assisted CBT program, CCAL, in the treatment of children and adolescents with ASD and co-occurring anxiety. This head-to-head trial made it possible to (1) evaluate the efficacy of CCAL for treating anxiety relative to another computer facilitated intervention that was not designed to treat anxiety; and (2) determine whether TSE would be helpful in improving social skills relative to CCAL which is not designed to improve social skills. This will be the first study to evaluate the efficacy of TSE in youth with ASD.

2. Methods

2.1. Participants

Twenty-seven participants recruited for the current intervention study included youth, chronologically aged between 8 years and 15 years, of age who met diagnostic criteria for at least one principal anxiety diagnosis (SAD- Social Anxiety Disorder, GAD-Generalized Anxiety Disorder, and/or SP- Social Phobia). The youth who participated in the research study had previously been diagnosed with ASD by a physician or psychologist and were currently receiving public school services through an Individual Educational Plan having met eligibility criteria for autism. Additional inclusion criteria required that the participants and their caregivers be fluent in English, had a verbal IQ of 70 or higher on the Wechsler Abbreviated Scale of Intelligence (WASI), no history of major mental illness (such as bipolar disorder, schizophrenia, or psychosis), and no physical impairments, (such as absence of hearing or vision) or any difficulties that would preclude them from participating in outdoor sports activities. The use of prescription psychotropic medication was allowed for this initial trial and required that the parent/caregiver answer a brief medical screening to track any medication changes while the participant was involved in the study.

2.2. Study design

2.2.1. Power analysis

The researcher used G*Power 3.1.9.2 software to conduct a power analysis to determine the required sample size for the study. Power analyses were examined for the proposed study based on the effect sizes reported by McNally-Keehn et al. (2013) a recent randomized controlled trial of CBT intervention for anxiety with ASD and anxiety. McNally-Keehn et al. (2013) reported a Cohen's d effect size of 1.35 (large effect) for parent-reported ADIS-P scores at post-treatment/post-waitlist. Based on these assumptions, and using G*Power 3.1.9.2 (Faul, Erdfelder, Lang, & Buchner, 2007) software for the sample size calculation (assuming an equal amount of patients in the CCAL and TSE groups), it was calculated that a total of 24 subjects were required; 12 in each group.

This research employed a randomized, cross-over, head-to-head treatment design. Participants were composed of two groups: Group 1 completed 12-session of CCAL treatment first and then 12-session of TSE intervention; Group 2 completed 12-sessions of TSE intervention program first and then 12-sessions of CCAL treatment.

2.3. Procedures

2.3.1. Recruitment, participation, and data collection

Participants for this study were composed of two groups. One group of participants completed the CCAL treatment first and then completed TSE intervention (Group 1), while the second group completed TSE intervention program first and then complete CCAL treatment (Group 2). As part of recruitment procedures the principle lead researcher provided supervisors who worked for a local agency that provided services to persons with ASD a letter of introduction and flyer that was to be given to the parents or caregivers of child-adolescents who fit the inclusion criteria. Through the letter, the researcher directed parents or caregivers who were interested in having their child participate in the study to contact the researcher. Additionally, an announcement was placed on Valerie's List, an informational website for persons living with or supporting those with ASDs, that included the contact information for individuals who

wanted to participate in the study.

The study was conducted at the agency facilities in San Diego or in the home of the participant (intervention delivered in clinic (n = 17), intervention delivered in home (n = 10)). Permission was granted by author A.L., who was the agency director at the time of the research study. A.L. also supervised the implementation of this study.

During the initial contact, a brief telephone screen/interview was conducted with the parents to assess eligibility for inclusion in the study. Upon being deemed appropriate for an intake assessment, parents were given the opportunity to schedule the intake assessment during the telephone screen/interview. All intake evaluations were conducted at the agency.

During the intake assessment, the parents and the youth were informed about the time commitment for the study (24 weeks), the sessions for the two treatment groups, and the exit assessment interviews and debriefing. Both parent and participant signed informed consent and consent to video/audio tape. The parent was given baseline/T1 parent report measures to be completed and returned by the first intervention session. With the parent, a diagnostic parent report assessment was conducted (ADIS-P). With the participant, cognitive assessments (WASI) were conducted and self-report questionnaires (FQS, SCAS-C, and MASC-C) were completed with the assistance of a research assistant if needed. For participants referred from the agency who had previously completed a cognitive assessment, within one year of intake, the parent was asked to sign a release of information to and from the appropriate entities so that scores could be obtained. The diagnostic and cognitive assessments were administered by trained graduate students who have been trained to 80 % reliability prior to assisting with the research study. ADIS-C/P interviews were audio taped and reviewed by the lead researcher for adherence purposes and diagnostic reliability. Assessors completing the assessments were not involved with that particular participant's intervention and were blind to treatment group at the start of the study. Effectiveness of the assessor-blind procedure was evaluated by asking assessors to answer two brief questions on a piece of paper regarding their knowledge of treatment group assignment upon completion of the diagnostic interview/assessment. Participants who met all inclusion criteria and who failed to meet exclusion criteria were randomly assigned to one of the two treatment groups, Group 1 or Group 2. After the lessons for the first 12-session programs were completed each participant crossed over (T2) into the second arm of the study, received primary and secondary measures, and then received 12-sessions of the alternative intervention program. At the conclusion of both interventions all youth participants underwent exit assessment and outcome measures were administered one final time (T3).

Four graduate students each holding a master degree in clinical psychology and who had previously completed a graduate course in CBT and had received supervised practicum training in CBT were trained in CCAL and TSE. They served as individual therapist facilitators for each participant. Therapy sessions lasted between 30 and 45 min. The therapists' role was to facilitate each computer guided session.

CCAL: Typically, patients would complete the first six sessions independently. However, we maintained a therapist facilitated format because of the additional behavior support that would be necessary to treat youth with ASD. The first 6 sessions are largely psychoeducational in nature. The participant is introduced to activities that help them learn to communicate about anxiety (physiological and thoughts), situations associated with anxiety, assessing levels of stress or anxiety, and identifying coping strategies such as relaxation. The last six sessions of CCAL typically requires assistance from a therapist or "coach" because they introduce exposure to uncomfortable situations (the therapist was the same one that facilitated the first 6 sessions in the present study).

TSE: includes a series of digital animated vignettes that provide opportunities to learn about core component skills that promote prosocial behavior. TSE was developed by a team including Psychologists (author A.L. served as a consultant), speech pathologist, special education teachers with ASD experience and parents). While not based on a single intervention modality, its core characteristics includes elements of social pragmatic communication, video modeling, social and cognitive appraisal (including imitation, perspective taking, empathy) and guided response options. Specific skills include: Self- Management, Group Participation, Conversations, Attentive Listening, Conflict Resolution, Relationship Management, Critical Thinking, & Non-Verbal Communication. Just as with CCAL the same therapist facilitated each of the twelve sessions by providing necessary prompts and support to each participant. TSE provides intrinsic feedback regarding participant response selections and guides participants to correct choices of inference regarding perspective taking or behaviors that would be appropriate for the context.

2.4. Instruments (See Appendix A for more detail about each measure)

2.4.1. Baseline measures

2.4.1.1. Demographic questionnaire and medical history questionnaire. The Demographic Questionnaire was used to collect demographic data from the parents and the youth, such as their age, racial background and the youth's school setting, while the Medical History Questionnaire contained relevant information on the youth's current and past medical history and medications. Both children and one parent were given baseline/Time 1 (T1) measures to be completed and returned by the first intervention session.

Wechsler Abbreviated Scale of Intelligence-2 (WASI-2; Canivez, Konold, Collins, & Wilson, 2009*).*

2.5. Instruments

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Table 1
Chi-Square Tests between Demographic Factors and Treatment Group.

Demographic	Group 1 (n = 12) *n* (%)	Group 2 (n = 12) *n* (%)	χ^2	*p*
Gender				
Female	0 (0%)	2 (17 %)	2.18	.140
Male	12 (100 %)	10 (83 %)		
Participant ethnicity				
Caucasian	8 (66 %)	11 (92 %)	2.47	.290
Native/American Indian				
Black/African American				
Asian/Pacific Islander				
Hispanic/Latino	1 (8%)	1 (8%)		
Other/Mixed Ethnicity	3 (25 %)			
Not Reported				
Parent ever been married				
Yes	12 (100 %)	12 (100 %)	–	–
No	0 (100 %)	0 (0%)		
Parent-education				
High school graduate	0 (0%)	1 (8%)	4.95	.292
Technical school	2 (17 %)	0 (0%)		
Some college	4 (33 %)	2 (17 %)		
College graduate	4 (33 %)	4 (33 %)		
Graduate school	2 (17 %)	5 (42 %)		
Parent-income level				
N/A or don't know	3 (25 %)	6 (50 %)	4.48	.483
$20−000-24,999	2 (17 %)	1 (8%)		
$25,000−29,999	1 (8%)	1 (8%)		
$35,000−39,999	2 (17 %)	0 (0%)		
$40,000−44,999	0 (0%)	1 (8%)		
$50,000 or more	4 (33 %)	3 (25 %)		
Medication tracker				
Never been on or not currently taking medication	8 (67 %)	7 (58 %)	0.18	.673
Currently taking medication	4 (33 %)	5 (42 %)		
Medication class				
NA	8 (67 %)	7 (58 %)	2.40	.663
SNRI, stimulant	1 (8%)	0 (0%)		
SSRI	1 (8%)	2 (17 %)		
Stimulant	2 (17 %)	2 (17 %)		
Stimulant, antihypertensive	0 (0%)	1 (8%)		
Treatment conducted at home or in clinic				
Clinic	7 (58 %)	7 (58 %)	–	–
Home	5 (42 %)	5 (42 %)		
Does participant meet diagnostic criteria for at least one primary anxiety disorder (T1)?				
Yes	12 (100 %)	12 (100 %)	–	–
No	0 (0%)	0 (0%)		
Does participant meet diagnostic criteria for at least one primary anxiety disorder (T2)?			9.88	.002
Yes	5 (42 %)	12 (100 %)		
No	7 (58 %)	0 (0%)		
Does participant meet diagnostic criteria for at least one primary anxiety disorder (T3)?			0.18	.673
Yes	5 (42 %)	4 (33 %)		
No	7 (58 %)	8 (67 %)		

Note: Due to rounding error, all percentages may not sum to 100 %.

2.6. Primary and secondary outcome measures (See Appendix A for detail)

Primary: Anxiety Disorders Interview Schedule- Child and Parent Interview Schedule (ADIS-C and ADIS-P; Silverman & Albano, 2004*).*
Social Skills Improvement System – Parent form (SSIS-P). (Gresham, Elliott, Vance, & Cook, 2011).
Secondary:
The Social Communication Questionnaire (SCQ; Rutter, Bailey, & Lord, 2003*).*
Multidimensional Anxiety Scale for Children – Child and Parent forms (MASC-C and MASC-P; March, Parker, Sullivan, Stallings, & Conners, 1997*). The MASC is a 39-item self-report measure of anxiety symptoms for children and adolescents.*
Spence Children's Anxiety Scale – Parent and Child forms (SCAS-P and SCAS-C; Spence, 1998*).*
Social Responsiveness Scale (SRS). (Constantino & Gruber, 2009, p.3).
Friendship Qualities Scale (FQS). (Bukowski, Hoza, & Boivin, 1994)

2.7. Intervention

Diagnostic and cognitive assessments were audio taped and reviewed by the lead researchers for adherence purposes and diagnostic reliability. Assessors completing the assessments were not involved with individual participant's intervention and were blind to treatment group at the onset of the study. Effectiveness of the assessor-blind procedure was evaluated by asking assessors to answer two brief written questions regarding their knowledge of treatment group assignment upon completion of the diagnostic interview/assessment. The current research study employed CCAL and TSE with no modifications to the original design or therapist manual. (Note: Both CCAL and TSE can be provided with a parent or therapist facilitator).

Participants who met all inclusion criteria and who failed to meet exclusion criteria were randomly assigned to one of the two treatment groups, Group 1 or Group 2. At Time 2, after the lessons for the first 12-session programs were completed each participant crossed over into the second arm of the study and were coded for primary and secondary outcome measures. They then received 12-sessions of the alternative intervention program. At the conclusion of both interventions all youth participants underwent exit assessment and outcome measures one final time.

A total of 27 individuals participated in the data collection process. Three participants dropped out and did not cross-over to the second phase of treatment with the other intervention. All three participants who dropped out were randomly assigned to the Group 1 treatment condition and therefore did not cross over to complete TSE intervention. Reason given for drop out included: (1) The primary caretakers cited conflict with school schedule; (2) interest in only the CCAL intervention; and (3) inability to meet for weekly sessions as required by the treatment. The final sample consisted of 24 participants.

2.8. Data analysis plan

The effects of each of the treatment interventions assessed in the cross-over design were tested primarily with repeated measures ANOVA and t-tests to assess simple effects. Chi-square analysis was also employed to assess demographic differences between the treatment groups. The main outcomes examined were: (a) the difference between the scores of the participants from the two groups from T1, T2, and T3 and (b) the significant main effect for time and the interaction between time and group from T1 to T2 and T2 to T3. The independent variables were the two treatment groups (Group 1 and Group 2) and time (pre-T1, mid-T2, post-T3 treatment).

3. Results

3.1. Examination of demographic characteristics

Tables 1 and 2 show key demographic, descriptive characteristics, and the comparison between the two study groups. Treatment Group 1 had lower verbal skills relative to Group 2.

Results indicated significant differences in WASI-2 Full Scale IQ scores between the treatment groups ($t(22) = -2.14$, $p = .044$). In addition, there were significant differences in WASI-2 Verbal Index scores between the treatment groups ($t = -2.43$, $p = .024$); (Group 1 $M = 88.7$; Group 2 $M = 100.33$) (Table 2).

Table 2
Independent Sample t-tests for Treatment Groups.

	Group 1		Group 2			
Continuous Variables	*M*	*SD*	*M*	*SD*	*t*(22)	*p*
Age	11.67	2.19	12.75	1.91	−1.29	.210
SCQ Total	20.33	2.93	18.58	2.54	1.56	.132
WASI Full Scale IQ	91.67	12.32	102.58	12.67	−2.14	.044
WASI Verbal Comprehension Index	88.75	11.83	100.33	11.50	−2.43	.024
WASI Perceptual Reasoning Index	96.17	11.72	104.33	11.12	−1.75	.094

3.2. Efficacy of anxiety intervention on primary the outcome variable (ADIS-P, parent interference rating (PIR)

A mixed-model ANOVA was conducted to examine whether youth with ASD and co-occurring anxiety who completed a computer-assisted CBT intervention (CCA) demonstrate significantly greater reductions in anxiety compared to youth with ASD who completed an alternate computer-assisted intervention aimed to target social skills training rather than anxiety, TSE. In this analysis, ADIS-P PIR scores were analyzed for differences between the three time periods, as well as between treatment groups (Table 3).

As predicted the results of the interaction term were significant, $F(2, 44) = 17.40$, $p < .001$, $\eta^2 = .442$, suggesting that there were significant differences in ADIS-P PIR across the three time periods between the two treatment groups simultaneously. A series of independent sample *t*-tests (See Table 3) were conducted and found that there were significant differences at Time 2, showing a reduction of anxiety between treatment groups ($t(22) = -4.39$, $p < .001$). After Group 2 crossed over into the alternate intervention and completed CCAL there were no longer significantly different (see Fig. 1).

3.2.1. Results of paired samples t-tests for ADIS-P PIR for Group 1

A paired samples *t*-test was conducted to compare ADIS-P PIR by time (T1 to T2 and T2 to T3) for Group 1. There was a significant difference in ADIS-P PIR for Group 1 from T1 ($M = 7.08$, $SD = 1.24$) to T2 ($M = 3.83$, $SD = 1.26$); $t(11) = 7.58$, $p < .001$. There was not a significant difference in ADIS-P PIR for Group 1 from T2 ($M = 3.83$, $SD = 1.26$) to T3 ($M = 3.75$, $SD = 1.42$); $t(11) = .364$, $p = .723$. These results suggest that CCAL had a statistically significant effect on the reduction of ADIS-P PIR from T1 to T2 and as expected, TSE intervention did not have a statistically significant effect on the reduction of ADIS-P PIR for Group 1 from T2 to T3.

3.2.2. Results of paired samples t-tests for ADIS-P PIR for Group 2

A paired samples *t*-test was conducted to compare ADIS-P PIR by time (T1 to T2 and T2 to T3) for Group 2. There was a significant difference in ADIS-P PIR for Group 2 from T1 ($M = 7.00$, $SD = 1.21$) to T2 ($M = 6.17$, $SD = 1.34$); $t(11) = 3.08$, $p = .010$. There was a statistically significant difference in ADIS-P PIR for Group 2 from T2 ($M = 6.17$, $SD = 1.34$) to T3 ($M = 3.50$, $SD = 0.90$); $t(11) = 9.38$, $p < .001$. These results suggest that TSE intervention had a statistically significant effect on the reduction of ADIS-P PIR from T1 to T2 and CCAL had a statistically significant effect on the reduction of ADIS-P PIR from T2 to T3 for Group 2. Specifically, both interventions resulted in a statistically significant reduction of ADI-P PIR between time periods. However, a clinically meaningful change (ADIS-P PIR < 4) was only observed when participants in Group 2 received the computer-assisted CCAL intervention.

3.2.3. Results of mixed-model ANCOVA for ADIS-P PIR

After controlling for the impact of IQ the results of the interaction term were still significant, $F(2, 42) = 15.38$, $p < .001$, $\eta^2 = .423$, suggesting that a significant differences in ADIS-P PIR between the interaction of time and treatment remained, while controlling for the effect of IQ scores. While the groups were equivalently matched for the presence of significant anxiety (ADIS-P PIR T1; 7.3 v. 6.78) only Group 1 showed a decrease in anxiety at T2 ($M = 3.94$) and maintained that decrease to T3 ($M = 3.73$). The crossover of Group 2 into the CCAL treatment condition at T2 resulted in a clinically significant decrease of anxiety at T3 ($M = 3.52$). This shows that only when children were treated with CCAL did anxiety decrease to non-clinical levels.

3.2.4. Number needed to treat analysis

Number Needed to Treat (NNT) statistic was calculated based on the return to non-clinical levels (Cut-point <4 raw score) based on the raw scores of the primary outcome variable, the ADIS-P. Pooled data across both treatment groups indicate that (2.17) participants must be given the computer-assisted CBT intervention in order for one child to return to non-clinical levels for their primary anxiety diagnosis at post-treatment (NNT = 2.17).

3.2.5. Results of anxiety secondary outcome measures

A series of analyses were conducted to examine for differences in the secondary outcome measures for anxiety, which corresponded to the MASC-C and MASC-P and the SCAS-C and SCAS-P. Independent sample t-tests were utilized for each secondary measure by treatment group.

3.2.6. MASC-C & MASC-P scores

A significant difference in Time 2 MASC-C scores between treatment groups ($t(22) = -2.21$, $p = .038$) was found (Table 4a), but no difference was found for MASC-P scores (Table 4b).

Table 3
Independent Sample t-tests for ADIS-P PIR by Treatment Groups.

	Group 1		Group 2			
Continuous Variables	*M*	*SD*	*M*	*SD*	*t*(22)	*p*
ADIS Interference Ratings (T1)	7.08	1.24	7.00	1.21	0.17	.869
ADIS Interference Ratings (T2)	3.83	1.27	6.17	1.34	−4.39	<.001
ADIS Interference Ratings (T3)	3.75	1.44	3.50	0.90	0.51	.613

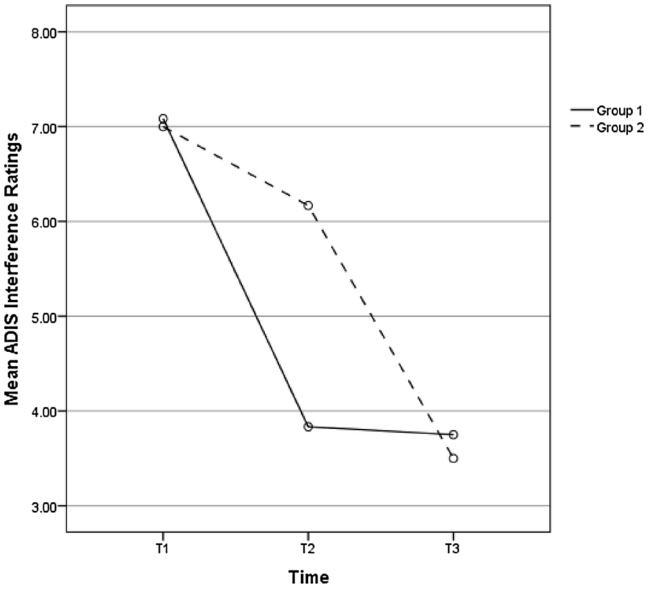

Fig. 1. Mean ADIS-P PIR by Time and Group.

3.2.7. SCAS-C & SCAS-P scores

A series of independent sample *t*-tests were conducted and found significant differences in Time 1 SCAS-C scores between treatment groups ($t(22) = -2.17$, $p = .041$) (Table 5a), while no differences were found for SCAS-P scores (Table 5b).

3.2.8. Results of social skills secondary outcome measures

A series of independent sample t-tests were conducted to examine for differences in the secondary outcome measures for social skills. The secondary measures for social skills correspond to the SRS and FQS total scores.

3.3. Efficacy of social skill intervention

Mixed-model ANOVA was used to determine whether youth with ASD and co-occurring anxiety who completed a computer assisted social skills training intervention. TSE would demonstrate significantly greater improvements in social skills functioning than youth who completed an alternate computer-assisted intervention aimed to target the treatment of anxiety rather than social skills training, CCAL. In a mixed-model ANOVA social skills scores (as measured by the SSIS-Parent scores) were analyzed for differences between the three time periods, as well as between treatment groups (Table 6).

3.3.1. Results of mixed-model ANOVA

Results of the within effect of the ANOVA were significant, $F(2, 44) = 37.64$, $p < .001$, partial $\eta^2 = .631$, showing that there were significant differences in SSIS-P scores between the three time periods. Results of the between effect of the ANOVA were not significant, $F(1, 22) = 0.49$, $p = .491$, $\eta^2 = .022$, suggesting that there were no significant differences in SSIS-P scores between the two treatment groups. Results of the interaction term were not significant, $F(2, 44) = 1.41$, $p = .254$, $\eta^2 = .060$, suggesting that there were no significant differences in SSIS-P scores between the three time periods and the two treatment groups, simultaneously (Table 6). A series of independent sample *t*-tests were conducted and found that there were not significant differences in SSIS-Parent scores between treatment groups at any time-period (Table 7).

3.3.2. Results of paired samples t-tests for SSIS-P scores for Group 1

A paired samples *t*-test was conducted to compare SSIS-P scores by time (T1 to T2 and T2 to T3) for Group 1. There was a significant

Table 4a
Independent Sample t-tests for MASC-C Scores by Treatment Groups.

	Group 1		Group 2			
Continuous Variables	*M*	*SD*	*M*	*SD*	*t*(22)	*p*
MASC-C Scores (T1)	58.00	11.93	61.42	12.75	−0.68	.505
MASC-C Scores (T2)	52.08	7.18	60.83	11.68	−2.21	.038*
MASC-C Scores (T3)	52.25	7.50	49.17	6.69	1.06	.299

Note: *$p < .05$.

Table 4b
Independent Sample t-tests for MASC-P Scores by Treatment Groups.

	Group 1		Group 2			
Continuous Variables	*M*	*SD*	*M*	*SD*	*t*(22)	*p*
MASC-P Scores (T1)	74.42	9.18	70.75	11.15	0.88	.389
MASC-P Scores (T2)	64.58	9.62	69.00	10.70	−1.06	.299
MASC-P Scores (T3)	61.83	9.04	55.50	7.14	1.90	.070

Table 5a
Independent Sample t-tests for SCAS-C Scores by Treatment Groups.

	Group 1		Group 2			
Continuous Variables	*M*	*SD*	*M*	*SD*	*t*(22)	*p*
SCAS-C Scores (T1)	55.08	8.49	48.00	7.47	2.17	.041*
SCAS-C Scores (T2)	51.92	9.01	47.33	7.41	1.36	.187
SCAS-C Scores (T3)	48.08	12.34	41.67	6.67	1.58	.127

Note: *$p < .05$.

Table 5b
Independent Sample t-tests for SCAS-P Scores by Treatment Groups.

	CCAL/TSE		TSE/CCAL			
Continuous Variables	*M*	*SD*	*M*	*SD*	*t*(22)	*p*
SCAS-P Scores (T1)	46.92	15.29	40.00	17.77	1.02	.318
SCAS-P Scores (T2)	32.17	12.66	36.58	17.37	−0.71	.484
SCAS-P Scores (T3)	29.92	12.06	22.42	11.80	1.54	.138

Note: *$p < .05$.

Table 6
Means and Standard Deviations for SSIS-P Scores by Time and Group.

Continuous Variables	*M*	*SD*
SSIS-P Scores (T1)		
Group 1	66.92	13.75
Group 2	60.42	12.34
Total	63.67	13.20
SSIS-P Scores (T2)		
Group 1	73.42	16.54
Group 2	71.83	6.98
Total	72.63	12.44
SSIS-P Scores (T3)		
Group 1	78.25	14.78
Group 2	75.92	11.07
Total	77.08	12.83

Mixed-Model ANOVA for SSIS-P Scores

Source	*F*	*p*	η^2
Within Effect (T1 vs T2 vs T3)	37.64	<.001	.631
Between Effect (Treatment Groups)	0.49	.491	.022
Within*Between (Time and Treatment Groups)	1.41	.254	.060

difference in SSIS-P scores for Group 1 from T1 ($M = 66.92$, $SD = 13.75$) to T2 ($M = 73.42$, $SD = 16.54$); $t(11)$=-3.73, $p = 0.003$. There was a significant difference in SSIS-P scores for Group 1 from T2 ($M = 73.42$, $SD = 16.54$) to T3 ($M = 78.25$, $SD = 14.78$); $t(11)$=-2.54, $p = 0.028$ (Table 8a). These results suggest that CCAL had a statistically significant effect on the increase in SSIS-P scores from T1 to T2. Specifically, participants in Group 1 who completed CCAL experienced clinically meaningful change with group mean SSIS-P scores improving from "impaired" to "low average" social skills functioning according to measure clinical cutoffs. Additionally, results from the paired samples *t*-test suggested TSE intervention had a statistically significant effect on the increase in SSIS-P scores for Group 1 from T2 to T3 however, no clinically meaningful change was observed with the group mean remaining in the low average clinical range (See Fig. 2).

Table 7
Independent Sample t-tests for SSIS-P Scores by Treatment Groups.

	Group 1		Group 2			
Continuous Variables	*M*	*SD*	*M*	*SD*	*t*(22)	*p*
SSIS-P Scores (T1)	66.92	13.75	60.42	12.34	1.22	.236
SSIS-P Scores (T2)	73.42	16.54	71.83	6.98	0.31	.763
SSIS-P Scores (T3)	78.25	14.78	75.92	11.07	0.44	.666

Table 8a
Paired Samples t-tests for SSIS-P scores Group 1.

Pair	Continuous Variables	M	SD	t(11)	*p*
Pair 1	SSIS-P Scores (T1)	66.92	13.75		
	SSIS-P Scores (T2)	73.42	16.54	−3.73	.003*
Pair 2	SSIS-P Scores (T2)	73.42	16.54		
	SSIS-P Scores (T3)	78.25	14.78	−2.54	.028*

Note: *$p < .05$.

3.3.3. *Results of paired samples t-tests for SSIS-P scores for Group 2*

A paired samples *t*-test was conducted to compare SSIS-P scores by time (T1 to T2 and T2 to T3) for Group 2. There was a significant difference in SSIS-P scores observed for Group 2 from T1 ($M = 60.42$, $SD = 12.34$) to T2 ($M = 71.83$, $SD = 6.98$); $t(11)$=-5.67, $p < 0.001$. There was not a statistically significant difference in SSIS-P scores for Group 2 from T2 ($M = 71.83$, $SD = 6.98$) to T3 ($M = 75.92$, $SD = 11.07$); $t(11)$=-1.76, $p = 0.107$ (Table 8b). These results suggest that TSE intervention had a statistically significant effect as well as clinically meaning change improving from "impaired" to "low average" social skills functioning according to measure clinical cutoffs, in participants' SSIS-P mean scores from T1 to T2 for Group 2. Additionally, CCAL did not have a statistically significant effect on the increase in SSIS-P scores from T2 to T3 for Group 2.

3.3.4. *FQS scores*

A series of independent sample *t*-tests were conducted and found no significant differences in FQS scores between treatment groups at any time-period.

3.3.5. *SRS scores*

A series of independent sample *t*-tests were conducted and found no significant differences in SRS scores between treatment groups at any time-period. (See Table 9), This likely reflects the general sensitivity of SRS to ASD diagnosis.

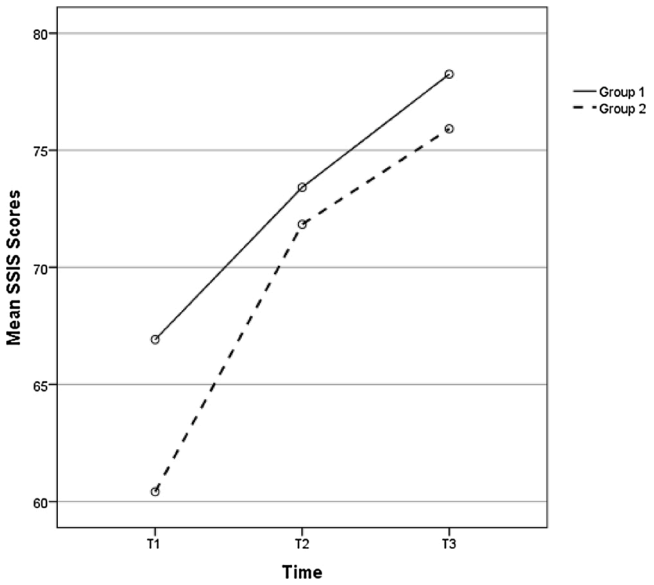

Fig. 2. Mean SSIS-P Scores by Time and Group.

Table 8b
Paired Samples t-tests for SSIS-P scores Group 2.

Pair	Continuous Variables	M	SD	t(11)	*p*
Pair 1	SSIS-P Scores (T1)	60.42	12.34		
	SSIS-P Scores (T2)	71.83	6.98	−5.67	.000*
Pair 2	SSIS-P Scores (T2)	71.83	6.98		
	SSIS-P Scores (T3)	75.92	11.07	−1.76	.107

Note: $*p < .05$.

4. Discussion

The present study is among the first of its kind to use an empirically supported computer-assisted CBT intervention to examine the efficacy of the CCAL CD-ROM for reducing anxiety symptom severity in youth with ASD. While TSE and CCAL both showed mixed evidence of improving social skills and anxiety symptoms in these participants, only the CBT intervention resulted in clinically significant improvement for anxiety. Thus, it is possible to improve social skills in youth with ASD who have co-occurring anxiety with CBT or a psychoeducational intervention, but only CBT showed clinical efficacy in improving anxiety. These findings are consistent with those reported of principal anxiety disorder remission for children with ASD and co-occurring anxiety who completed the 16-week face-to-face CBT Coping Cat intervention (Kendall, 1994; McNally-Keehn et al., 2013) and other CBT anxiety interventions (Vasa et al., 2014 review; Storch et al., 2015; Weston et al., 2016 review).

Findings from the present study show that youth with ASD and anxiety exhibit clinically significant reductions in anxiety following the 12-session CCAL intervention. The findings of anxiety symptoms reduction and/or elimination on the ADIS-P, is consistent with the first known intervention study of the Coping Cat Program for Children with ASD and co-occurring anxiety, in which a similar treatment related effect on the ADIS-P were obtained (McNally-Keehn et al., 2013). Drmic, Aljunied, and Reaven (2017), also found similar results in reduction symptoms on the ADIS-P in children with ASD and co-occurring anxiety when participating in a school CBT based intervention (Drmic et al., 2017).

By utilizing a computer-assisted intervention that yields equivocal clinical efficacy to more standard behavioral interventions, barriers to treatment could potentially be reduced by improving treatment feasibility and ease of dissemination for clinicians. Furthermore, the current findings further support the current literature that stated computer based or computer-assisted modalities may be as efficacious in the context of a therapist supported augmentation (as was done in this study) to that of clinic-based, face-to-face CBT in the treatment of anxiety disorders among youth (McNally-Keehn et al., 2013; Spence et al., 2011). For example, our earlier work showed the efficacy of the Coping Cat, therapist provided CBT approach for anxiety treatment in youth with ASD. Similar results were found in the current study that employed a computer-assisted intervention, CCAL.

An additional clinical implication of the present study is maintenance of treatment gains. The findings obtained in the present study are consistent with and further support past literature on maintenance of treatment gains following the CBT based Coping Cat Program for treating anxiety in youth (Khanna & Kendall, 2010; McNally-Keehn et al., 2013). The findings obtained in the current study provide preliminary evidence supporting the efficacy of CCAL for maintaining significant treatment effects in youth with ASD and co-occurring anxiety following a 12-week period. Currently, McNally-Keehn et al. (2013) is the only known published study to report ADIS-P follow-up data to date. However, we cannot rule out the effects of 12 weeks of CCAL might not have been maintained if the participants had not had 12 additional weeks of contact with the same therapist and a structured intervention (although it was not CBT).

The present study obtained an NNT = 2.17 which is comparable or superior to those reported by pharmacological research examining evidence-based approaches to treating pediatric anxiety (Strawn & McReynolds, 2012) and had a small dropout rate. While a multi-modal treatment approach has been found most effective in treating anxiety in youth (Strawn & McReynolds, 2012), there remains the potential of adverse events with psychopharmacological interventions. Moreover, the intervention required minimal financial support. One purchase was required to obtain the CCAL software that could be downloaded onto multiple computers and laptops. Essentially, a therapist might "prescribe the intervention" as an augmentation to their therapy while allowing the child with the assistance of the parent or the child alone to complete the training. Additionally, treatment adherence checks were a built-in feature of the CCAL program. Ease of dissemination, treatment acceptability, adherence, and cost to therapist all make the CCAL a feasible intervention option.

We found that both treatment interventions, CCAL and TSE, had a beneficial effect on anxiety in the youth that were followed in the current study. This is noteworthy because while social-communication deficits are necessary and must be present for an ASD diagnosis, anxiety is not a necessary finding for the diagnosis. However, anxiety is a prevalent co-occurring or possibly comorbid condition with ASD. Social-communication deficits may increase vulnerability to basic developmental challenges and consequently increase the potential for anxiety to develop (Pickard, Rijsdijk, Happé, & Mandy, 2017). Its possible that interventions that also improves social-communication challenges may result in the development of skills that can be used to navigate and more successfully resolve conflict that otherwise would increase vulnerability to anxiety. In the present study we found preliminary evidence that the TSE has some positive effect with respect to anxiety reduction.

Data examined in the present study were derived from participants with varying range of intellectual abilities and varying ethnic and socio-economic backgrounds. In addition, the present study involved multiple sites, with treatment being delivered both in clinics and in participants' homes. For these reasons, generalizability across youth with ASD and co-occurring anxiety with comparable

Table 9
Independent Sample t-tests for SRS Scores by Treatment Groups.

	Group 1		Group 2			
Continuous Variables	*M*	*SD*	*M*	*SD*	*t*(22)	*p*
SRS Scores (T1)	105.25	15.33	107.67	21.39	−0.32	.753
SRS Scores (T2)	99.25	16.28	96.42	21.12	0.37	.716
SRS Scores (T3)	95.17	19.36	91.50	20.82	0.45	.659

profiles could be supported.

Despite the promising findings there are some noteworthy limitations of the present study. These limitations include the relatively small sample size, the sample of primarily Caucasian male youth, and the entire sample drawing from southern California. The decision to use TSE as the comparative treatment was made because it was computer facilitated, could be conducted in roughly the same time frame and was designed for persons with ASD. It was felt such characteristics were superior to employing a treatment as usual comparison group or no treatment control. However, because this was the first efficacy study of TSE, one could question whether it may have been more beneficial to compare to another specific treatment for anxiety or non-anxiety CBT treatment.

5. Conclusion

The present study is the first to investigate the efficacy of a computer-assisted program, CCAL on treating anxiety in youth with ASD utilizing a quantitative mixed model design. Upon examination of the primary social skills outcome measure (SSIS-P), it was concluded that participants obtained clinically significant improvements in social skills regardless of intervention delivered. While these results provide important information and preliminary evidence that CCAL could be considered an efficacious intervention for children with ASD and co-occurring anxiety, the findings further support outcomes reported that the Coping Cat model is an effective intervention in reducing anxiety symptoms this population. Moreover, this is the first evidence showing the efficacy of TSE in youth with ASD. Moreover, the TSE also appeared to have a positive impact on anxiety symptoms in these participants. Continued research is warranted to further support the findings obtained in the current study and to add to the scarce literature on the efficacy of computer-assisted modalities in treating youth with ASD.

CRediT authorship contribution statement

Felicia Cruz Pryor: Conceptualization, Methodology, Writing - original draft. **Alan Lincoln:** Conceptualization, Methodology, Writing - original draft. **Robyn Igelman:** Conceptualization, Methodology, Writing - original draft. **Varvara Toma:** Conceptualization, Methodology, Writing - original draft. **Roya Iravani:** Conceptualization, Methodology, Writing - original draft.

Declaration of Competing Interest

The authors report no declarations of interest.

Acknowledgements

Special thanks to the Center for Autism Research, Evaluation and Service Foundation, San Diego, California for providing space and referral for the current research study.

Appendix A. Instruments and Measures

Demographic Questionnaire and Medical History Questionnaire. The Demographic Questionnaire was used to collect demographic data from the parents and the youth, such as their age, racial background and the youth's school setting, while the Medical History Questionnaire contained relevant information on the youth's current and past medical history and medications.

Wechsler Abbreviated Scale of Intelligence (WASI). The WASI is a measure of general intelligence designed for individuals aged 6–89. The WASI includes four subtests; Vocabulary and Similarities, which combine to measure Verbal-Crystallized abilities, and Block Design and Matrix Reasoning, which combine to measure general intelligence (Canivez et al., 2009). As such, this test assesses both verbal and performance skills, estimating an individual's level of intellectual functioning. Higher scores indicate greater intellectual ability. The WASI was administered to all participants who did not have a verifiable Full-Scale IQ score from school records or testing completed at CARES.

Primary Outcome Measures: Anxiety Disorders Interview Schedule- Child and Parent Interview Schedule (ADIS-C and ADIS-P; Silverman & Albano, 2004**).** The ADIS-C and ADIS-P are structured interviews developed for diagnosing childhood anxiety disorders based on DSM-IV criteria. The ADIS-C and ADIS-P consists of independent child and parent interviews that enable the assessor to obtain information about past and current symptomatology, course, etiology, and severity of anxiety and problem behaviors and to screen out additional disorders. The ADIS-C/P also allows clinicians to make a severity rating for each diagnosis based on the information obtained in the interview. Inter-rater agreement of the ADIS-P/C was determined by comparing clinician ratings of

153 subjects aged 7–16, and was found to be excellent (Ung et al., 2014). Test-retest reliability for these instruments range from .70 to .92 (Silverman, Saavedra, & Pina, 2001). The ADIS-C and ADIS-P has shown sensitivity to treatment effects in outcome studies (e.g., Kendall et al., 1997). The parent-report ADIS- P PIR was utilized for inclusion purposes (i.e., to determine the presence and severity of anxiety diagnoses) and as the primary outcome variable in the current study.

Social Skills Improvement System – Parent form (SSIS-P). The SSIS was formulated to address the need for an evidence-based multi-tiered assessment and intervention system to help students with academic or social behavior difficulties. The SSIS is used to document the perceived frequency of behaviors that influence development of social competence and adaptive function both inside and outside the home (Gresham et al., 2011). As such, it can be used to screen students aged 8–18 who display significant social skill deficits and as a basis for designing intervention or treatment programs (Crosby, 2011). In the present study, the SSIS-P social skills subscale will be used to assess the participant's current social functioning by asking questions regarding academic competence, conversation skills, ability to follow directions and emotional expression, among others. There are 79 items in the instrument that consists of two scales; Social Skills and Problem Behavior. SSIS-P social skills subscale has a total raw score range of 0–138 with clinical cutoffs reported as; 0−49= profoundly impaired, 50−71= impaired, 72−83= low average, 84−109= average, 110−121= high average, and 122−138= superior. For the purpose of the present study, only the social skills scale was examined. SSIS-P social skills subscale total raw scores were used as a primary outcome variable for examining social skills.

Secondary Outcome Measures

The Social Communication Questionnaire (SCQ; Rutter et al., 2003). The SCQ us a 40-item, parent-report screening measures that examines the symptomology associated with ASD. The questionnaire is completed with reference to the individual's behavior during the most recent 3-month period or lifetime, and produces results that are pertinent to understanding everyday living experiences and evaluating treatment plans. It is applicable to subjects of any chronological age above 4.0 years provided that their mental age is at least 2.0 years. The primary, validated application of the SCQ results in a single Total Score taken from the Lifetime form that is then interpreted with reference to cutoff scores drawn from the research reported on the instrument. A cutoff scores of >15 identifies individuals who are likely to suffer from an ASD and for whom more extended evaluations should be undertaken. The purpose of including the SCQ in the current study is supplementary due to the fact that participants did not complete diagnostic ASD assessments during baseline measure obtainment, rather were required to have a pre-existing diagnosis. The SCQ was used as a screener and outcomes were observed to evaluate group differences.

Multidimensional Anxiety Scale for Children – Child and Parent forms (MASC-C and MASC-P). The MASC is a 39-item self-report measure of anxiety symptoms for children and adolescents. It consists of six scales; SAD/Phobias, GAD Index, SoP, OCD, Physical Symptoms, and Harm Avoidance. The MASC is often used to screen for anxiety disorders, and to discriminate between youths with anxiety disorders and those with other disorders. The content of the parent and child scales are similar, although the language of the child version has been modified for self-report purposes. Cronbach's alpha values for the child version range from .74 to .85 and .57 to .83 for the parent version (Thaler, Kazemi, & Wood, 2010). Test-retest reliability for the instrument was determined to be .93 (Yen, Yang, Wu, Hsu, & Cheng, 2010). A total T score can be obtain in addition to T scores on each of the six subscales. For the present study, MASC-C and MASC-P total T scores will be examined as a secondary outcome variable.

Spence Children's Anxiety Scale – Parent and Child forms (SCAS-P and SCAS-C; Spence, 1998). The SCAS is a 45-item self-report questionnaire designed to assess children's report and parent report of anxiety and provide information about specific childhood anxiety disorders. Thirty-eight items address specific symptoms of anxiety and 6 positive items are included to reduce the chance for negative response bias. The scale measures six specific domains of anxiety, namely generalized anxiety, panic/agoraphobia, social phobia, separation anxiety, obsessive-compulsive disorder, and physical injury fears. Participants are asked to rate the degree to which they experience the symptoms listed on the instrument using a 4-point frequency scale. In clinical contexts, the SCAS is used for assessment and therapy evaluation purposes, especially for the evaluation of the impact of therapy on anxiety-related symptoms for children and adolescents.

Social Responsiveness Scale (SRS). The SRS is a 65-item instrument focusing on the different dimensions of interpersonal behavior, communication and stereotypic behavior that characterize autism spectrum disorders. The SRS is designed for children or adolescents between 4 and 18 years of age. The instrument is completed by a teacher, parent, or caregiver familiar with the child's current behavior and developmental history. The results on the SRS are used to identify Autistic Disorder, Asperger's Disorder, PDD-NOS, and Schizoid Personality Disorder of Childhood. While most diagnostic instruments focus on establishing the presence or absence of a disorder, the SRS allows for the "identification of sub-threshold levels of autistic symptomatology relevant to the assessment and management of children with a wide variety of psychological problems" (Constantino & Gruber, 2009, p. 3). Interpretation of the test is based on the sum of the responses to all 65 questions, but there are five subscales, namely Social Awareness, Social Cognition, Social Communication, Social Motivation and Autistic Mannerisms. Validation of the SRS was conducted over the four-year period during which the instrument was developed, within the context of studies on autism spectrum disorders. Reliability tests resulted in alpha values above .90 for both genders in both clinical and normative samples.

Friendship Qualities Scale (FQS). The FQS was developed as a multidimensional instrument to assess the qualities of children's and early adolescents' relationships with their best friends (Bukowski et al., 1994) by asking respondents to indicate the trueness of a sentence on their best friendship using a 5-point Liker scale (Kendall et al., 1997). This 23-instrument instrument examines the five features of friendship quality, namely companionship, help, security, closeness, and conflict (Kendall et al., 1997). This rating is based on five dimensions of friendship, namely conflict, help/aid, security and closeness (Bukowski et al., 1994). The instrument is used to assess the characteristics that make up friendships like supportive behaviors, time spent together and common interests.

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