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Internet-based, parent-led cognitive behavioral therapy for autistic youth with anxiety-related disorders: A randomized trial comparing email vs. telehealth support

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ABSTRACT

This study tested two versions of parent-led, Internet-delivered cognitive behavioral therapy for anxiety among autistic youth; one that provided weekly email support (iCBT-Email), and one that provided alternating bi-weekly emails and video calls (iCBT-Video) across 12 weeks. It was expected that those in the iCBT-Video condition would complete more treatment content, which in turn would lead to more anxiety improvement. Fifty-seven autistic youth (7-15 years-old) with anxiety disorders were randomized to iCBT-Email or iCBT-Video. There were no significant differences in improvement in clinician-rated, child-reported, or parent-reported anxiety severity or functional impairment. Posttreatment response rates were 55% in iCBT-Email and 67% in iCBT-Video. Module completion predicted improved treatment outcome, though there was no difference in module completion across groups. Therapists spent an average of 16.29 min/family/week (SD = 7.11) in the iCBT-Email condition and 24.13 min/family/week (SD = 6.84) in the iCBT-Video condition. Email and telehealth-supported, parent-led iCBT both appear to be effective treatments for autistic youth with anxiety disorders that require reduced therapist effort. Future research should seek novel methods to enhance engagement with iCBT content.
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1. Introduction

Autism is a common neurodevelopmental difference characterized by social communication difficulties as well as repetitive and restrictive behaviors, with 1 in 36 children now estimated to be autistic (Maenner, 2020). Autistic youth often struggle with a number of mental health conditions, with anxiety-related disorders being among the most common in this population (Kirsch et al., 2020; van Steensel et al., 2011). Clinical anxiety confers significant functional impairment in autistic youth (Kerns et al., 2015) and is likely to worsen as youth enter adolescence and adulthood (Gotham et al., 2015; Uljarević et al., 2020).

An increasing recognition of the prevalence and impact of anxiety in this population has led to an acceleration of treatment research in the past decade, with particular interest in cognitive behavioral therapy (CBT) due to its strong evidence base for anxiety-related disorders in non-autistic youth (Sharma et al., 2021; Wood et al., 2020). Several randomized trials have now demonstrated strong efficacy of CBT relative to comparison conditions for this population (g = .88; Sharma et al., 2021). Although CBT as it was designed for non-autistic youth is efficacious, one randomized trial comparing traditional CBT to CBT adapted for autistic youth suggested modifications for autistic youth lead to incremental benefits, as youth in the adapted condition experienced

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significantly improved outcomes in this study (Wood et al., 2020).

Regardless, there are tremendous barriers to accessing adapted CBT for this population, as it is time-intensive, costly, and rarely available in community settings (Reardon et al., 2020; Salloum et al., 2016). Further, there is a significant shortage of providers trained in CBT for children and adolescents (Frank et al., 2020). Although this problem is significant for all youth, these barriers are even more substantial among those on the autism spectrum, as there is often a disconnect between developmental services (where this population is often seen) and mental health services. Moreover, providers are often hesitant to provide therapy for autistic youth (Adams & Young, 2021; Maddox et al., 2021). For these reasons, developing lower-cost, more scalable approaches for this population is of utmost importance.

Internet-delivered CBT (iCBT) has been proposed as a novel form of delivery that has the potential to increase access to CBT, reduce costs, and save therapist time, while maintaining efficacy (Andersson et al., 2019). These approaches generally involve automated educational and interactive material that youth and parents complete in their own time with minimal therapist contact, ranging from asynchronous messaging to occasional phone/telehealth contact to provide support as they work through a self-directed program. Self-directed programs for youth with anxiety disorders usually follow a parent-led approach, in which parents take on the role of a therapist and coach with support from a clinician. This format has been recommended as parents may be more likely to generalize concepts from CBT, help their child apply them in real time, and are often more motivated to engage in difficult behavior change related to child anxiety (Creswell et al., 2022). Several studies have shown non-inferiority of parent-led CBT relative to therapist-delivered individual treatment for non-autistic youth with anxiety disorders (Creswell et al., 2022; Rapee et al., 2017), with recent research demonstrating similar treatment outcomes for autistic youth (Guzick et al., 2023). Leveraging digital health and parent coaching promises to be a lower cost method to scale CBT for autistic youth.

To date, there has been minimal research on digitally delivered CBT for autistic youth with anxiety-related disorders. One pilot study of an iCBT program for autistic youth with anxiety-related disorders compared two levels of therapist support. In this 12-week program, eight parent-youth dyads were randomized to receive either biweekly, 30-min video calls with a therapist in addition to weekly email support (iCBT-Video) or weekly email support only (iCBT-Email) (Guzick et al., 2023). All families participated in parent- and child-specific web-based modules between therapist contacts, with parents being encouraged to guide their child through their content. Overall, treatment outcomes were promising, with five of seven completers being classified as treatment responders and an overall symptom reduction of 39% on the Pediatric Anxiety Rating Scale modified for Autism (PARS-A; Maddox et al., 2020), including a 55% reduction in iCBT-Video and a 22% reduction in iCBT-Email [blinded citation].

ICBT for non-autistic youth has incorporated different levels of professional support in the form of a therapist or "coach," with greater involvement generally being associated with improved outcomes (Grist et al., 2019; Werntz et al., 2023). In addition to providing clarification on therapeutic concepts, more contact with a professional during digital mental health interventions is believed to confer more "supportive accountability," leading to greater engagement with therapeutic material and less dropout (Meyerhoff et al., 2021). Indeed, several studies show that more human support leads to more engagement in digital mental health interventions (though it is also worth noting several non-significant findings in this literature as well; Lipschitz et al., 2023). In parent-led interventions, greater parental participation leads to improved outcomes (Riddle et al., 2024). Thus, it may be that increased participation in therapeutic content is a mechanism by which more therapist contact leads to improved treatment outcomes in parent-led digital mental health interventions. That said, there are diminishing returns of therapist involvement at a certain point when considering the balance of efficacy and scalability in digital mental health interventions that should be considered in treatment development.

This study expanded on preliminary findings by testing two versions of iCBT for autistic youth with anxiety-related disorders, one with weekly email contact (iCBT-Email), and one with alternating bi-weekly email contact and 30-min telehealth coaching calls (iCBT-Video). The primary aim was to test whether families in iCBT-Video would experience improved treatment outcomes. A secondary aim was to test whether greater engagement with iCBT content in the iCBT-Video condition would be a mechanism accounting for improved treatment outcomes among families in this condition. It was expected that families randomized to iCBT-Video would engage with more iCBT content and thus experience improved treatment outcomes compared to families in the iCBT-Email condition. Other secondary exploratory aims were to compare satisfaction and dropout across the two treatment conditions. We also compared the amount of therapist time required in each condition, with more therapist time expected in iCBT-Video.

2. Methods

2.1. Participants

Participants were recruited from a variety of sources throughout the state of Texas including autism-focused organizations, mental health and developmental clinics and professionals, research databases (e.g., SPARK, ResearchMatch), social media platforms (e.g., Facebook), community organizations (e.g., advocacy groups, schools, churches, youth centers, local businesses, non-profits), and word of mouth. Recruitment began in July 2022 and ended in March 2023.

Parents interested in participating first completed a 30-min prescreening phone call with a member of the study team to determine their child's likely eligibility prior to scheduling a virtual baseline assessment. Written and verbal consent/assent was obtained prior to beginning the baseline assessment, during which parent and child completed a series of interview-rated assessments and questionnaires with a trained independent evaluator to determine final eligibility. Independent evaluators were trained by reviewing assessments with a licensed psychologist experienced in the measures, rating mock assessments to ensure reliability with the team, administering an initial assessment with the support of an experienced rater, and weekly supervisions with a supervising psychologist. Independent evaluators were blind to treatment condition.

Inclusion criteria required the following: (1) a child age of 7–15 years at time of enrollment, (2) a prior diagnosis of autism according to gold-standard assessment procedures (e.g., Autism Diagnostic Observation Schedule, Second Edition [ADOS-2]; Childhood Autism Rating Scale, Second Edition [CARS-2]) verified by a written report and reviewed by a clinical psychologist on the study team, (3) a primary diagnosis of an anxiety or obsessive-compulsive disorder on the Mini International Neuropsychiatric Interview for Children and Adolescents (MINI-KID; Sheehan et al., 2010), (4) a score of 70 or higher on the Kaufman Brief Intelligence Test, Second Edition (KBIT-2; Kaufman & Kaufman, 2004), (5) child-demonstrated ability to communicate verbally during the assessment, (6) parent and child English fluency, (7) at least one parent or guardian willing to participate in assessments and treatment modules, (8) and full-time residency of both child and parent in the state of Texas during the trial period. Exclusion criteria included (1) the child had a diagnosis of bipolar disorder, conduct disorder, or a psychotic disorder, (2) the child had current and severe suicidal/homicidal ideations, (3) the child was currently receiving psychotherapy for anxiety through another provider, or (4) the child had started or changed dosages of psychotropic medications within the four weeks prior to the baseline assessment.

2.2. Procedures

After completion of a virtual baseline assessment, eligible parent-

child dyads were randomized into one of two iCBT treatment conditions in a 1:1 allocation ratio: iCBT-Email or iCBT-Video. A research coordinator uninvolved with the study used the pseudorandom function in Microsoft Excel to assign blocks of 10 participants into iCBT-Email vs. -Video condition. After each eligible participant was enrolled, this research coordinator was notified and they were entered into the subsequent cell. This research coordinator informed another coordinator directly involved in the study, who in turn informed families of their group assignment. In both conditions, parents were sent two links each week to access the treatment modules corresponding to the week of the program they were on: one link containing parent-facing content and the other containing child-facing content. The child content had two versions that varied based on the child's age (one for 7-10 year-olds, one for 11-15 year-olds). All procedures were approved by the local Institutional Review Board. The study was pre-registered here: https://clinicaltrials.gov/study/NCT05284435.

Learning to Understand and Navigate Anxiety (LUNA). Participants in both treatment conditions followed the LUNA program across a 12-week period (Guzick et al., n.d.), during which families were encouraged to complete one treatment module per week. For this study, content was delivered using Qualtrics survey software (*Qualtrics*, 2020), so therapists could monitor families' responses and provide feedback. Therapists were postdoctoral fellows or doctoral students in psychology supervised by a licensed psychologist experienced with this population. Families were not given access to content for subsequent weeks until they completed their current module to avoid treatment burden and overload, though when families fell behind, they were given up to two modules to complete in one week if they expressed an interest in completing additional content. The program began with three modules on psychoeducation (Modules 1 and 2), rewards (Module 2), and coping (Module 3), with the rest reviewing different facets of exposure therapy. Module 4 focused on exposure hierarchy development, Module 5 on doing exposure, Module 6 on testing expectancies through exposure, and Module 7 on safety behaviors and family accommodation. After these first seven core modules, parents chose between five additional supplemental modules (working on multiple exposure goals simultaneously; social coaching during social anxiety exposures; modifying exposures for anxiety related to sensory sensitivity and insistence on sameness; exposure during the COVID-19 pandemic; managing oppositional behavior). Teens could access parallel modules for all these areas except for the parent coaching module on oppositional behavior, and children could access the multiple exposure goals module. A final module provided a review of material and planning for the future.

iCBT-Email. Families randomized to the iCBT-Email condition completed weekly LUNA treatment modules one at a time while receiving 12 weekly check-in emails from their therapist. Therapists reviewed participant progress on the previous week's module prior to emailing the family to provide feedback on areas for improvement and techniques for implementing program content into their everyday lives. Emails were generally brief and intended to be no more than a few sentences providing encouragement, basic feedback on modules, and/or checking in on completion when content was not done on time. Templates were generated for each email which therapists personalized to each family.

iCBT-Video. Families randomized to the iCBT-Video condition completed weekly LUNA treatment modules one at a time while receiving both email and video support from their therapist, with six bi-weekly email check-ins alternating with six bi-weekly, 30-min telehealth coaching calls. Parents and youth attended these visits together. During video sessions, therapists provided additional support and strategies for implementing techniques learned throughout the program in addition to the written feedback provided via email during the weeks families were not scheduled to meet with their therapist. Content covered during video sessions included changes in functioning since the previous session, answering questions about the previous week's content, offering support and encouragement, troubleshooting problems with the program, identifying barriers to participation if the family was not keeping up with the modules, and providing feedback on CBT exercises conducted in the home. Consistency in therapy delivery was maintained through content checklists for each session that therapists followed as well as weekly supervision.

2.3. Measures

Clinical assessments were administered to both parent and child across three timepoints via secure videoconferencing: prior to treatment (Baseline), immediately after treatment (posttreatment), and one month after treatment ended (1 Month Follow-Up). Assessments included a variety of clinician-rated measures and parent/child-reported measures and were conducted by postdoctoral fellows or advanced doctoral trainees trained as independent evaluators and supervised by a licensed psychologist.

MINI-KID: The Mini International Neuropsychiatric Interview for Children and Adolescents (MINI-KID; Sheehan et al., 2010) is a short, structured diagnostic interview used to assess DSM-5 disorders among youth and has shown strong psychometric properties across both clinical and general populations (Duncan et al., 2018; Sheehan et al., 2010). 18% of MINI-KIDs were re-rated by an independent rater, finding agreement of $\kappa = .80$, indicating substantial agreement.

PARS-A: The Pediatric Anxiety Rating Scale modified for Autism (PARS-A; Maddox et al., 2020) is a semi-structured interview that measures anxiety symptoms and severity in youth, which occurred over the past week. It includes a symptom checklist of anxiety symptoms across social anxiety, separation anxiety, generalized anxiety, specific phobia, and panic domains and five items assessing the severity of the following: frequency, distress, avoidance, impairment at home, and impairment outside the home. The PARS-A was modified from the original Pediatric Anxiety Rating Scale (PARS) to better assess anxiety in autistic youth and shows strong test-retest reliability and convergent validity (Maddox et al., 2020). Consistent with our prior work, additional checklist items were included to assess for symptoms of obsessive-compulsive disorder (OCD), in line with the study's conceptualization of OCD as an anxiety-related disorder. 18% of PARS-A were re-rated by independent raters, finding an interclass correlation of .87, indicating a strong degree of agreement.

CGI-I: The Clinical Global Impression-Improvement Scale (CGI-I) is a brief, seven-item, clinician-administered measure that assesses global improvement in clinical symptoms (Guy, 1976). Clinicians used the CGI-I in the present study to rate participants' improvement of anxiety symptoms following treatment completion and treatment efficacy overall. The measure has shown strong psychometrics properties and reliability across raters (Lewin et al., 2012).

CSDS: The Child Sheehan Disability Scale (C-SDS) is a brief self- and parent-reported measure used to determine degree of functional and anxiety-related impairments in children (Whiteside, 2009). It was originally adapted from the Sheehan Disability Scale and was administered as both a child- (C-SDS-C) and parent- (C-SDS-P) report to determine impairment across social, educational/occupational, and family domains. The CSDS has shown strong psychometric properties, including strong internal consistency and concurrent validity (Whiteside, 2009).

RCADS: The Revised Child Anxiety and Depression Scale (RCADS; Chorpita et al., 2000) is a 47-item self-report, adapted from the Spence Children's Anxiety Scale (SCAS; Spence 1998), that measures anxiety and depressive symptoms among children and adolescents. The measure consists of both child (RCADS-C) and parent (RCADS-P) self-reports and has been shown to have strong psychometric properties (Chorpita et al., 2005). The anxiety subscale was reported in this study.

CSQ-8: The Client Satisfaction Questionnaire-8 (CSQ-8) is a brief, eight-item self-report measure administered to assess client satisfaction with treatment services. It has shown high internal consistency (Attkisson & Zwick, 1982; Nguyen el al., 1983) and was delivered as a

parent-reported measure in this study.

2.4. Statistical analysis

Data conformed to normal distribution assumptions. 16–19% of data were missing on primary and secondary outcomes; when missingness was assessed using Little's test, we failed to reject the null hypothesis that data were missing completely at random, X^2 (11) = 7.90, p = .72. Multiple imputation was used to estimate missing data, with the following inputs to generate imputed models: baseline demographics (child age, sex), baseline symptoms scores on all primary and secondary outcomes, and baseline diagnoses.

Primary outcomes included differences in rate of change in PARS-A scores across the treatment period and one-month follow-up. Sample size was determined to detect an effect size difference of f = .39 based on the pilot trial (Guzick et al., 2023), assuming power = .90, alpha = .05, and a correlation coefficient across timepoints of r = .47 (also based on data from prior work). Based on these assumptions, 27 were expected to be needed in each group to yield a significant difference favoring iCBT-Video.

Multilevel random effects models were conducted to determine differences in rate of change in PARS-A scores, with visits (Baseline, Post-Treatment, 1 Month Follow-Up) nested within participants. Analyses were conducted in in SPSS v29 (IBM Corp, 2022). The following independent variables were added in sequential models predicting PARS-A scores: 1) age (child vs. teen), 2) linear time, 3) quadratic time (to evaluate if the rate of change slowed between post-treatment and the one-month follow-up period), 4) treatment group (iCBT-Video vs. iCBT-Email), and 5) the interaction between linear time and treatment group. The magnitude of fixed effects were estimated using a marginal Pseudo R2 (Nakagawa et al., 2017). Analyses were repeated for secondary outcomes, including RCADS-P, RCADS-C, CSDS-P, and CSDS-C.

Rates of treatment response (a CGI-I score of "much" or "very much" improved), primary anxiety diagnosis remission, and remission of all anxiety diagnoses were compared using chi-square analyses. Completer-only and intent-to-treat are both presented, with missing data being estimated across five imputed datasets.

Participant engagement was defined as the number of modules completed. Time spent per module was also presented. Differences in engagement were investigated by comparing the number of modules completed in iCBT-Email vs. iCBT-Video with a t-test. Association between module completion and treatment outcome was conducted by including the number of modules completed as well as the interaction between number of modules completed and time as additional independent variables in the multilevel models.[1] Assuming significant differences between groups in treatment outcomes, as well as a significant association between module completion and treatment outcomes, a mediated regression was planned to investigate whether the effect of group on post-treatment PARS, RCADS-P, and RCADS-C was mediated by the number of modules completed

3. Results

3.1. Participant characteristics

The majority of youth in this study identified as boys (72%), White (70%), and non-Hispanic (72%). The most common diagnoses included social anxiety disorder (67%), generalized anxiety disorder (58%), and specific phobia (53%). Please see Table 1 for a full demographic summary and Fig. 1 for the CONSORT diagram describing participant flow. Enrollment occurred from August 1, 2022, to March 29, 2023, with the final follow-up assessment being completed in August 2023. Enrollment ended once the target sample size was reached. Adverse events and harms were monitored using the definition adopted by the local institutional review board ("An undesirable and unintended, although not necessarily unexpected, result arising during the course of a research protocol"). No adverse events or harms were reported during the trial.

3.2. Improvement in anxiety and impairment in iCBT-Email vs. iCBT-Video

Clinician-rated anxiety severity measured by the PARS-A showed a significant negative linear effect, B = 3.74, p = .007 ΔR^2 = .33, suggesting a decline in PARS-A across the trial (see Fig. 2). There was no time X iCBT condition effect, B = 0.19, p = .64. Age (adolescent vs. child modules completed) was not a significant predictor. This pattern of findings was replicated when examining the RCADS-P (parent-rated anxiety), RCADS-C (child-rated anxiety), CSDS-P (parent-rated

Table 1
Demographics table and baseline clinical characteristics.

	Full sample n = 57	iCBT-Email n = 29	iCBT-Video n = 28
Anxiety diagnosis, N (%)			
Specific Phobia	30 (53%)	16 (55%)	14 (50%)
Social Anxiety Disorder	38 (67%)	18 (62%)	20 (71%)
Separation Anxiety	17 (30%)	11 (38%)	6 (21%)
Generalized Anxiety Disorder	33 (58%)	17 (59%)	16 (57%)
Selective Mutism	4 (7%)	3 (10%)	1 (4%)
Obsessive-Compulsive Disorder	12 (21%)	7 (24%)	5 (18%)
Panic disorder	1 (2%)	0 (0%)	1 (4%)
Baseline PARS-A, M (SD)	17.82 (2.63)	17.68 (2.56)	17.96 (2.74)
Age, M (SD)	11.05 (2.54)	11.00 (2.49)	11.11 (2.63)
Child Gender, N (%)			
Boy	41 (72%)	23 (79%)	18 (64%)
Girl	16 (28%)	6 (21%)	10 (36%)
Race			
White	40 (70%)	20 (69%)	20 (71%)
Black or African American	3 (5%)	1 (3%)	2 (7%)
Asian	8 (14%)	3 (10%)	5 (18%)
American Indian or Alaskan Native	1 (2%)	1 (3%)	0 (0%)
Multiple Races	3 (5%)	3 (10%)	0 (0%)
Other	2 (4%)	1 (3%)	1 (4%)
Ethnicity			
Hispanic or Latino	16 (28%)	10 (35%)	6 (21%)
Not Hispanic or Latino	41 (72%)	19 (66%)	22 (79%)
Parent 1 education			
High school diploma	2 (4%)	1 (3%)	1 (4%)
Some college	6 (11%)	3 (10%)	3 (11%)
Technical/trade/vocational school	1 (2%)	0 (0%)	1 (4%)
Associate's degree	2 (4%)	0 (0%)	2 (7%)
Bachelor's degree	19 (33%)	10 (35%)	9 (32%)
Graduate degree	27 (47%)	15 (52%)	12 (43%)
Parent 2 education			
Partial high school	1 (2%)	1 (3%)	0 (0%)
High school diploma	7 (12%)	4 (14%)	3 (11%)
Some college	8 (14%)	4 (14%)	4 (14%)
Associate's degree	3 (5%)	2 (7%)	1 (4%)
Vocational school	3 (5%)	0 (0%)	3 (11%)
Bachelor's degree	16 (28%)	7 (24%)	9 (32%)
Graduate degree	18 (31%)	11 (38%)	7 (11%)
Other	1 (2%)	0 (0%)	1 (4%)

Note: CBT = cognitive behavioral therapy; PARS-A = Pediatric Anxiety Rating Scale modified for Autism.

[1] Number of parental modules completed was chosen as an index of overall engagement as opposed to an aggregate of child and parental modules completed because 1) LUNA was designed as a parent-led treatment, 2) number of parental modules completed and child modules completed were extremely highly correlated, r = .97, and 3) there were different numbers of child (9) and teen (12) modules, and thus aggregating child/teen modules would introduce variability related to the intervention design rather than an index of engagement.

Table 2
Multilevel model examining change in primary and secondary outcomes across the trial.

	B [a]	p	ΔR^2_{pseudo} [a]
PARS-A			
Age (Child vs. Teen modules completed)	−1.30	.28	.012
Time	**−3.74**	**.007**	**.33**
Quadratic time	0.44	.22	.011
Treatment group	.69	.59	.010
Time X treatment group	.19	.64	.001
RCADS-Anxiety-Parent report			
Age (Child vs. Teen modules completed)	−2.70	.41	.008
Time	−3.97	.14	.071 [b]
Quadratic time	0.70	.40	.005
Treatment group	−0.84	.83	.025
Time X treatment group	−1.75	.14	.010
RCADS-Anxiety-Child report			
Age (Child vs. Teen modules completed)	−5.88	.15	.021
Time	−2.96	.47	.070 [b]
Quadratic time	0.35	.73	.002
Treatment group	1.97	.70	.017
Time X treatment group	−3.04	.067	.017
CSDS-Parent report			
Age (Child vs. Teen modules completed)	−2.90	.31	.013
Time	−5.29	.17	.135 [b]
Quadratic time	0.83	.46	.014
Treatment group	1.98	.53	.001
Time X treatment group	−1.18	.18	.004
CSDS-Child report			
Age (Child vs. Teen modules completed)	−3.88	.059	.044
Time	−3.43	.183	.137 [b]
Quadratic time	0.48	.512	.011
Treatment group	1.66	.449	.001
Time X treatment group	−0.65	.411	.005

Notes: PARS = Pediatric Anxiety Rating Scale-modified for Autism; RCADS = Revised Child Anxiety and Depression Scale; CSDS = Children's Sheehan Disability Scale.

[b] ΔR^2_{pseudo} is presented as the change in the marginal ΔR^2_{pseudo} when each independent variable was entered in a separate model compared to the previous model.

[a] B coefficients are presented for the final model with all independent variables included.

[b] Time was a significant predictor in an earlier model without other independent variables included, $p < .05$.

functional impairment), and CSDS-C (child-rated functional impairment). The only distinction in these models was that time showed a significant negative linear effect for each dependent variable in models without other covariates included, ΔR^2s = .070 - .137, though when other variables were also included in the model, they no longer showed statistical significance See Table 2 for model coefficients and effect sizes; see Table 3 for a summary of population-predicted *M*s and *SE*s.

3.3. Response and remission in iCBT-Email vs. iCBT-Video

There were no significant differences in treatment response or remission at post-treatment or one-month follow-up. At posttreatment, 67% of completers in iCBT-Video and 55% of completers in iCBT-Email were classified as responders. In iCBT-Video, 33% remitted from their primary anxiety disorder and 21% remitted from all anxiety diagnoses. Comparatively, in iCBT-Email, 46% of completers remitted from their primary anxiety diagnosis and 32% remitted from all anxiety diagnoses. At one-month follow-up, 75% of completers in iCBT-Video and 60% of completers in iCBT-Email were classified as responders. 55% of participants in each condition remitted from their primary anxiety disorder diagnosis at one-month follow-up, with 20% of iCBT-Video participants remitting from all anxiety diagnoses and 35% in iCBT-Email. See Table 4 for a summary of clinical significance data with both completer and intent-to-treat samples.

3.4. Engagement

There was no significant difference between the number of parent modules completed in the iCBT-Video condition, *M (SD)* = 6.68 (3.30), and the iCBT-Email condition, *M (SD)* = 5.21 (3.70), t (55) = 1.34, p = .12, d = −.42. There was similarly no difference between number of child modules completed in the iCBT-Video condition, *M (SD)* = 6.32 (3.17), and the iCBT-Email condition, *M (SD)* = 5.10 (3.66), t (55) = 1.58, p = .19, d = −.36.

Number of modules completed, as well as the interaction between number of modules completed and time, were added as additional independent variables in models predicting treatment outcome on the PARS-A, RCADS-P, and RCADS-C. The interaction between number of modules completed and time was a significant predictor of PARS-A scores, B = −.13, p = .007, RCADS-P scores, B = −.33, p = .024, suggesting that completing more modules corresponded with more change across the trial. It was not a significant predictor of RCADS-C, however, B = .070, p = .72. See Table 5 for a summary of these effects.

3.5. Dropout and satisfaction

Eight families dropped out of the iCBT-Email condition, compared with five families in the iCBT-Video condition, X^2 (1) = 0.77, p = .38. Ratings on client satisfaction indicated no differences across groups on the Client Satisfaction Questionnaire, t (31) = 1.38, d = .48, p = .18.

3.6. Therapist time

In the iCBT-Email condition, therapists spent an average of 16.29 min of therapist time per week (*SD* = 7.11) per family, compared to 24.13 min (*SD* = 6.84) in the iCBT-Video condition, t (41) = 3.68, d = 1.12, $p < .001$. Therapists in iCBT-Email spent an average of 6.70 min per week (*SD* = 3.45) reviewing content, and 9.59 min per week providing email feedback (*SD* = 3.96). These numbers were similar among iCBT-Video therapists with time reviewing, *M (SD)* = 6.30 (4.21), and average email feedback time, *M (SD)* = 7.88 (4.64), though they also had video sessions every other week, which were an average of 27.77 min (*SD* = 3.58).

4. Discussion

This study tested two formats of parent-led, Internet-delivered CBT for autistic youth with anxiety-related disorders, one involving weekly email check-ins (iCBT-Email) and one that also included biweekly telehealth coaching calls (iCBT-Video). There were no significant differences in treatment outcomes across groups in evaluator-, child-, or parent-rated anxiety, child- and parent-reported functional impairment, drop-out, or satisfaction with services. The majority of youth in both iCBT-Email and iCBT-Video experienced clinically significant change, with 55% and 67% being classified as treatment responders at the posttreatment assessment, respectively. Primary anxiety disorder remission rates at posttreatment were 46% in iCBT-Email and 33% in iCBT-Video, which increased to 55% in both conditions at 1-month follow-up. All-anxiety disorder remission rates were 38% in iCBT-Email and 25% in iCBT-Video (inclusive of OCD). These response and remission rates are generally comparable to those reported in traditionally-delivered CBT for anxiety among autistic youth (Warwick et al., 2017), and in digital CBT for non-autistic youth with anxiety disorders (Cervin & Lundgren, 2022).

These comparable improvements across conditions were observed while using less therapist time in iCBT-Email, with 16 min/week/family in this condition compared with 24 min/week/family in iCBT-Video. Although this reflected a significant and large difference in statistical terms, its practical significance (i.e., 8 min/therapist/week) is less compelling. Both conditions require far less therapist time relative to traditional psychotherapy (i.e., 45–60 min weekly sessions), and are

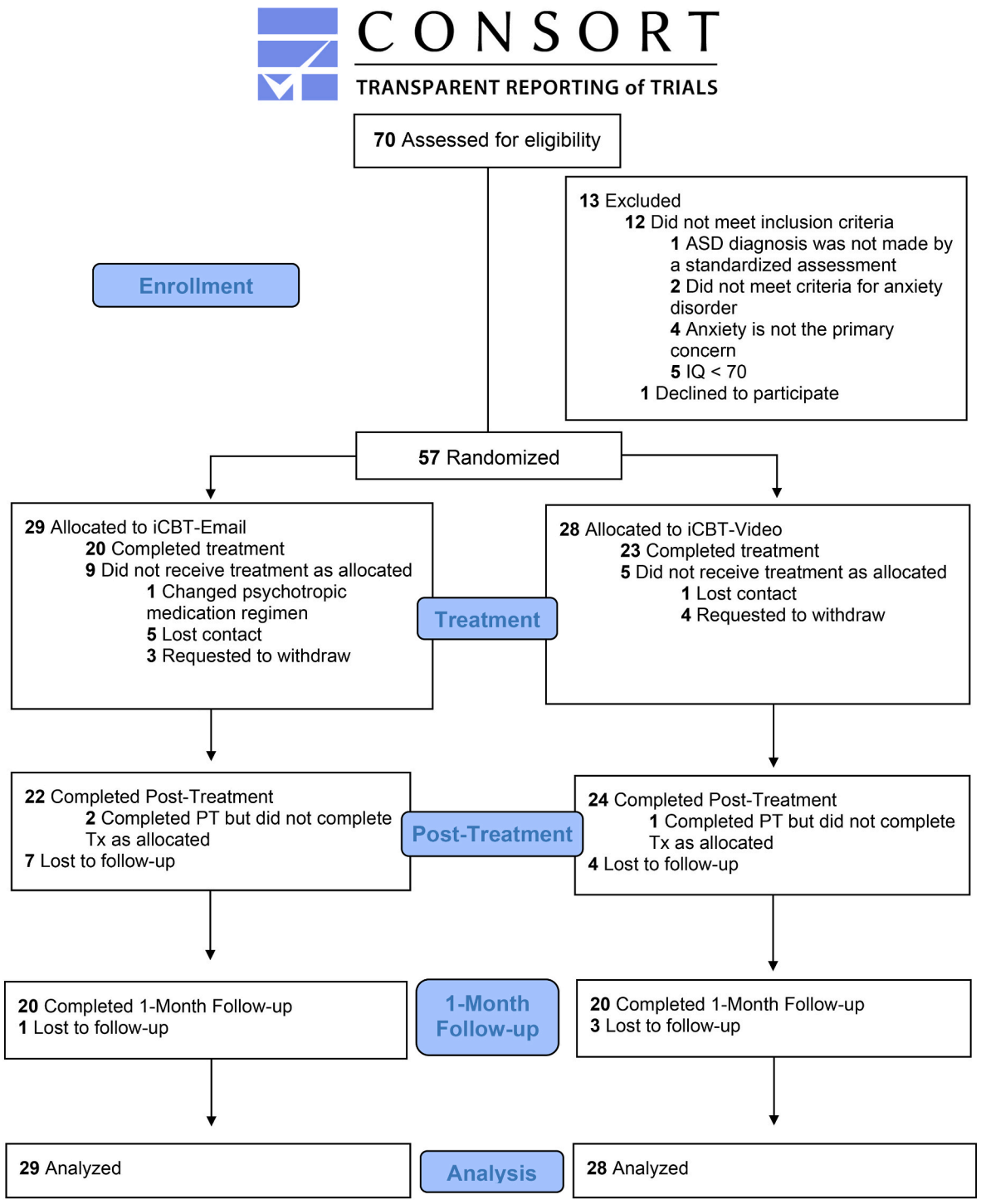
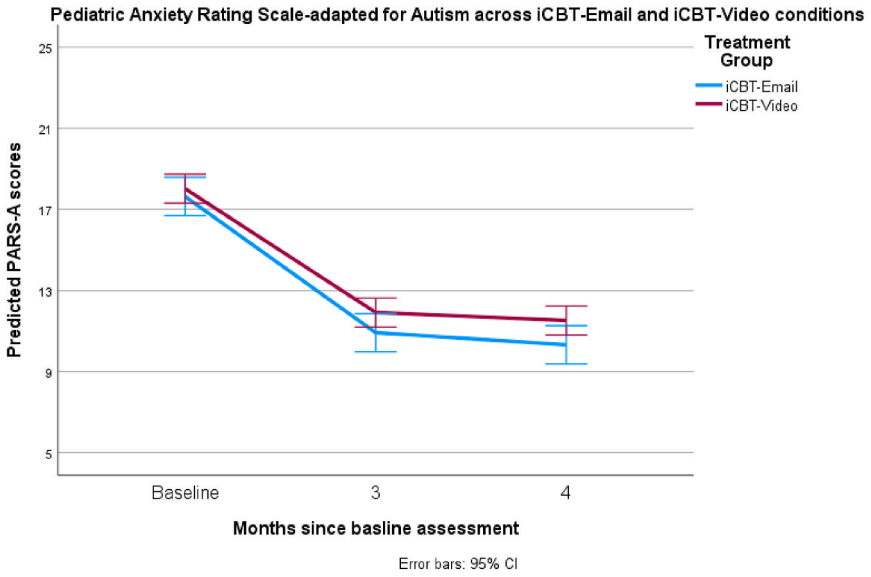


Fig. 1. CONSORT diagram.

both in the range of therapist time that has been reported in other digital CBT programs (Werntz et al., 2023). Given the minimal difference across formats, they might both be considered as viable options depending on family preferences and the systems in which they are delivered. For example, iCBT-Video might be more easily implemented in the United States, where this trial was conducted. In this context, there is an existing payment mechanism for 30-min psychotherapy sessions through a Current Procedural Terminology (CPT) code, whereas there is not a mechanism to pay therapists to write supportive feedback emails. It is also possible that if therapy time is used on more therapeutically potent components in future iterations (e.g., delivering in-session exposure to supplement self-guided practice at home), this may also boost the impact of therapist visits.

Hypotheses regarding the role of content completion were partially supported. Content completion *was* a significant predictor of IE-rated and parent-reported anxiety improvement, though participants in iCBT-Video *did not* complete a significantly higher number of iCBT modules as expected. It appeared that the weekly therapist check-ins in the iCBT-Email condition were sufficient to support some degree of engagement with the material, with minimal incremental benefits coming from biweekly telehealth coaching calls. Overall, content completion was less than optimal and highly variable from participant-



Note: PARS-A = Pediatric Anxiety Rating Scale adapted for Autism; iCBT = Internet-delivered cognitive behavioral therapy

Fig. 2. Anxiety improvement across iCBT groups.
Note: PARS-A = Pediatric Anxiety Rating Scale adapted for Autism; iCBT = Internet-delivered cognitive behavioral therapy.

Table 3
Means and standard errors of population-predicted outcomes.

	Post-treatment				One-month follow-up			
	iCBT-Email		iCBT-Video		iCBT-Email		iCBT-Video	
	M	SE	M	SE	M	SE	M	SE
PARS-A	10.32	0.87	11.53	0.87	9.71	0.88	11.08	0.88
RCADS-Anxiety-Parent report	32.47	2.49	26.09	2.48	33.13	2.51	24.54	2.50
RCADS-Anxiety-Child report	29.40	3.34	21.99	3.33	29.01	3.36	18.37	3.36
CSDS-Parent report	15.85	1.99	14.24	1.99	16.33	2.01	13.62	2.01
CSDS-Child report	5.54	1.58	5.27	1.58	5.80	1.60	4.96	1.60

Note: iCBT = Internet-delivered cognitive behavioral therapy; PARS-A = Pediatric Anxiety Rating Scale-modified for Autism; RCADS = Revised Child Anxiety and Depression Scale; CSDS = Children's Sheehan Disability Scale.
Population-predicted models were derived from linear mixed models with the following independent variables included: pre-treatment scores, age, time, quadratic time, treatment condition, and the interaction between treatment condition and time.

Table 4
Clinically significant change in iCBT-Email and iCBT-Video.

	Post-treatment							
	Completers				Intent-to-treat			
	iCBT-Email n = 22	iCBT-Video n = 24	X^2 (1)	p	iCBT-Email n = 29	iCBT-Video n = 28	X^2 (1)	p
Treatment responder	12 (55%)	16 (67%)	0.71	.40	20 (69%)	20 (71%)	0.11	.74
Remission from primary anxiety diagnosis	10 (46%)	8 (33%)	0.71	.40	11 (38%)	10 (36%)	0.36	.55
Remission from all anxiety diagnoses	7 (32%)	5 (21%)	0.72	.40	11 (38%)	7 (25%)	1.52	.22
	One-Month Follow-Up							
	Completers				Intent-to-treat			
	iCBT-Email n = 20	iCBT-Video n = 20	X^2 (1)	p	iCBT-Email n = 29	iCBT-Video n = 28	X^2 (1)	p
Treatment response	12 (60%)	15 (75%)	1.03	.31	21 (72%)	23 (82%)	0.98	.32
Remission from primary anxiety diagnosis	11 (55%)	11 (55%)	0.00	1.00	13 (45%)	14 (50%)	0.41	.52
Remission from all anxiety diagnoses	7 (35%)	4 (20%)	1.13	.29	10 (35%)	8 (29%)	0.45	.50

Note: iCBT = Internet-based cognitive behavioral therapy. Treatment responder was defined as a score of "much" or "very much improved" on the Clinical Global Impressions – Improvement Scale (CGI-I).

Table 5
Multilevel model examining change in primary and secondary outcomes across the trial.

	B	p	ΔR^2_{pseudo}
PARS-A			.032
Number of modules completed	.057	.71	
Number of modules completed X time	**−.13**	**.007**	
RCADS-Anxiety-Parent report			.020
Number of modules completed	.32	.53	
Number of modules completed X time	**−.33**	**.024**	
RCADS-Anxiety-Child report			<.001
Number of modules completed	.031	.97	
Number of modules completed X time	.070	.72	

Notes: Models include all independent variables presented in Table 2 as covariates.
CSDS = Children's Sheehan Disability Scale; PARS = Pediatric Anxiety Rating Scale-modified for Autism; RCADS = Revised Child Anxiety and Depression Scale.

to-participant, with an average of just about half of all possible modules completed during the 12-week treatment period. Thus, rather than families in iCBT-Email completing *more* than an expected number of modules, it appears the biweekly telehealth calls with a therapist for families in the iCBT-Video condition did not engender a sufficient degree of supportive accountability. Given the association between content completion and improvement in anxiety, future work should continue to consider novel ways to enhance engagement with CBT in self-directed interventions beyond these telehealth calls (e.g., gamification for youth; parental social support embedded in the application; or just-in-adaptive-interventions to support parents leading the program between therapist visits). It is also worth noting non-significant associations between content completion and youth self-reported anxiety improvement. Although parent- and independent evaluator-rated outcomes are generally favored in interpretation in this population, the lack of an association between engagement and child-reported treatment outcome may suggest that children's self-reported experience of anxiety was less impacted by the degree of participation in the program. Other child-specific factors or treatment processes may prove to be better predictors of child self-reported outcomes (e.g., intrinsic motivation, insight, development of self-efficacy).

Several study limitations should be noted. First, the lack of a non-CBT or no-human-involvement control group precludes definitive conclusions about efficacy or the degree of human contact that is required to support participation in CBT content. Second, this trial was conducted in a highly controlled setting where participants were monitored regularly, in consistent communication with study staff, and primarily from higher socioeconomic backgrounds; it is less clear how these findings might generalize to real-world, community-based settings that serve families from more multiculturally diverse backgrounds. No fidelity assessments were conducted for the intervention, an important limitation of our study and the digital interventions field more broadly. Further, this study was powered to test efficacy of iCBT-Video vs. iCBT-Email using a small pilot trial that likely overestimated the magnitude of differences between the two conditions. Given the relatively small sample size, it was likely not powered to detect mechanisms, an important area for future work. The sample size also limited our ability to find significant differences in moderately-sized effects (e.g., in the client satisfaction questionnaire analysis). This study was also limited by a relatively short-term follow-up period.

This study adds to the growing literature on parent-led, Internet-delivered CBT for autistic youth with anxiety disorders, finding response and remission rates comparable to those often reported in traditional CBT trials for autistic youth (Warwick et al., 2017). Leveraging the growing presence of technology in the mental health landscape is a clear way to support parents as they take on a CBT coach role. Future work should seek novel ways to foster engagement with self-directed interventions to produce improved outcomes, assessing the impact of human contact (or lack thereof) on treatment outcomes in self-directed, digital interventions, identify mechanisms of change, and methods to implement this model of therapy on a larger scale.

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CRediT authorship contribution statement

Andrew G. Guzick: Writing – review & editing, Writing – original draft, Visualization, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Sophie C. Schneider:** Writing – review & editing, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Minjee Kook:** Writing – review & editing, Project administration, Data curation. **Rebecca Greenberg:** Writing – review & editing, Writing – original draft, Project administration, Data curation. **Amanda Perozo-Garcia:** Writing – review & editing, Project administration, Data curation. **Morgan P. Lee:** Writing – review & editing, Project administration, Data curation. **Jessica Garcia:** Writing – review & editing, Project administration. **Ogechi Cynthia Onyeka:** Writing – review & editing, Project administration. **David B. Riddle:** Writing – review & editing, Supervision, Project administration. **Eric A. Storch:** Writing – review & editing, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization.

Declaration of competing interest

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Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.

org/10.1016/j.brat.2024.104639.

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