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Virtual reality assisted cognitive behavioural therapy for social anxiety in autistic adolescents: A case series

Uddin, Tasnim

Awarding institution:
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Volume I

Systematic Review & Empirical Project

Thesis submitted in partial fulfilment of the degree of

Doctorate in Clinical Psychology

Tasnim Uddin

Institute of Psychiatry, Psychology & Neuroscience

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I dedicate my thesis and doctorate to my Ammu, who has sacrificed everything for her children, always putting her needs second to ours. Thank you for all you have done and continue to do – love you always mumma. আপনি বিশ্বের প্রাপ্য

VOLUME I

Chapter I

Systematic review

Adaptations to Cognitive Behavioural Therapy for Autistic Children and Young People with anxiety: A systematic review

Note: This paper has been submitted for publication with the Review Journal of Autism and Developmental Disorders

Supervisors: Dr Matthew Hollocks, Dr Lucia Valmaggia

Second Reviewer: Sailaa Sunthararajah

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ABSTRACT

BACKGROUND: Children and young people with autism are at a higher risk of developing anxiety disorders. While the effectiveness of cognitive behavioural therapy (CBT) for anxiety in autistic youths is well-researched, less is known about the active ingredients to adapting therapy.

AIMS: This systematic review aimed to synthesise the adaptations for CBT for anxiety in autistic children and young people. Should there be a sufficient body of research, this review also aimed to compare the effectiveness of these adaptations.

METHOD: Searches were conducted across five databases including EMBASE, MEDLINE, PsycINFO, PubMed and Web of Science. The search results were then evaluated against inclusion/exclusion criteria. Data from the included studies were extracted before conducting a narrative synthesis to summarise the findings. Quality assessment for the included studies was completed using the Evaluation of Public Health Practice Projects

RESULTS: 23 eligible studies were included in the review, comprising of 1,100 participants. These studies were generally of strong to moderate methodological quality. Findings highlighted the importance of practical modifications, parent and teacher input, affective education, skills training, and feedback and practice of CBT tasks as key adaptations. Due to an insufficient number of studies examining each adaptation, we could not make comparisons for effectiveness.

CONCLUSIONS: Adapted clinical practice can be used when delivering interventions for autistic youths experiencing anxiety. Future research should carefully examine the effectiveness of these adaptations to understand their value before examining how well adapted CBT is implemented within healthcare services. Likewise, research should examine how adaptations can be optimised across different demographic groups.

KEYWORDS: Autism spectrum disorder; Cognitive behavioural therapy; Anxiety disorders; Systematic review

INTRODUCTION

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition that is characterised by difficulties in social interaction and communication as well as restricted and repetitive patterns of behaviour (DSM-V; APA, 2013). Up to two-thirds of autistic children and young people experience a co-occurring mental health condition (Lai et al., 2019). While reports on prevalence have varied in research, there is a higher risk of developing anxiety disorders: one review found that 39.6% of autistic teenagers meet the criteria for at least one anxiety disorder (Van Steensel et al., 2011). Of these disorders, specific phobia (29.8%), obsessive-compulsive disorder (OCD; 17.4%) and social anxiety disorder (16.6%) were found to be the most common (Van Steensel et al., 2011). Increased levels of anxiety in autistic children and young people can greatly impact social and emotional wellbeing, relationships, and school performance (Fujii et al., 2012; Reaven et al., 2011). Anxiety is known to impact adaptive functioning and is one of the leading reasons for referrals to mental health services (Hallett, et al., 2013; Skokauskas & Gallagher; 2012). Therefore, the development of adapted interventions for anxiety for those with ASD is a key healthcare priority.

The National Institute of Health and Care Excellence (NICE; 2013) recommends cognitive behavioural therapy (CBT) as a first-line treatment for anxiety in children and adolescents. CBT is a talk-based intervention that integrates thoughts, feelings, and behaviours (Beck 1976). Some core components of CBT include psychoeducation, behavioural activation, cognitive restructuring, graded exposure and relaxation training (Kendall & Hedtke, 2006). CBT is an effective and evidence-based intervention that supports a range of anxiety disorders (Wang et al., 2017). In a review including over 87 studies, CBT was shown to increase post-treatment remission of primary anxiety disorders in typically developing youths compared to treatment as usual or waitlist (James et al., 2020).

Considerable effort has been made in research to understand the effectiveness of CBT for autistic children and young people. A growing evidence-base supports the use of CBT for autistic youths with anxiety in a variety of formats including individual, group, parent-mediated and online (Conaughton et al., 2017; Kilburn et al., 2020; Storch et al., 2015; Wood et al., 2015). Two review studies have reported moderate effect sizes for the overall effectiveness of CBT for anxiety in autistic children. Ung et al. (2014) examined 14 randomised control trials (RCTs) including a total of 511 youths and found a significant treatment effect in reducing anxiety symptoms based on parent, clinician, and self-reports, with an overall effect size of g = 0.71. Perihan and colleagues' (2019) metanalysis of 23 studies (N = 745) found a moderate effect size of g = 0.66 in the reduction of anxiety symptoms across parent, clinician, and self-reports. However, more recent reviews have highlighted that while CBT shows promise as an intervention for anxiety disorders in autistic youths, the magnitude of effect was dependent on the informants. That is, whether outcome measures were completed by clinicians, parents, or clients themselves to suggest bias within research (Sharma et al., 2021).

For those completing CBT, there is a need for high levels of emotional literacy and an ability to reflect on alternative perspectives. Autistic youths may find this challenging due to their restricted communication and rigid behaviour profiles which, in turn, can act as a significant barrier to engagement (Sharma et al., 2021). CBT also requires individuals to be able to attend to internal stimuli including sensations, emotions and thoughts which are other impacted areas for autistic individuals (Palser et al., 2020). As such, there has been considerable effort to adapt CBT for autistic children and young people to enhance its delivery and, therefore, client engagement. Lang et al. (2010) described how modifications such as emphasis on behavioural change over cognitive interventions should be made as there is less dependence on introspection. Other adaptations reported in the literature include accommodating clients' communication style, use of concrete language and parent involvement (Perihan et al., 2019; Spain & Happé, 2019). Spain and Happé (2019) highlighted that as CBT is structured, collaborative and often focuses on behavioural tasks such as graded exposure, it can be modified effectively to accommodate autistic populations.

Research has primarily focused on understanding the overall effectiveness of CBT for autism and less is known about the active ingredients when adapting this intervention. It is unclear from previous reviews which adaptations are commonly used, the features of delivering such adaptations and which, if any, are the most effective for this population. Understanding the key adaptations for CBT can be used to inform clinical practice which then increases client engagement and treatment effectiveness.

As such, the aims of the current review are as follows:
Primary

- To systematically review published literature on CBT for anxiety in autistic children and young people with means of synthesising the adaptations for therapy

Secondary

- Should a sufficient body of research be available:
    - To compare the effectiveness of adapted CBT with standard CBT for anxiety in autistic children and young people
    - To examine which adaptation demonstrates the greatest level of effectiveness, i.e., whether different adaptations are associated with better outcomes

METHOD

Our systematic review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines (Moher et al, 2009; 2016). The review protocol was registered with PROSPERO: CRD42023429990.

Eligibility Criteria

The PICO (Population, phenomena of Interest, Context, Outcome) framework (Lockwood et al., 2015) was used to inform the search strategy.

Population

Studies with participants under 18 years old were eligible for this review. Eligible studies required participants to have a formal diagnosis of ASD which was diagnosed by a psychiatrist, psychologist, or other trained clinicians. This includes Asperger's syndrome, high-functioning autism, childhood autism, atypical autism or Pervasive Developmental Disorder Not Otherwise Specified, according to the Autism Diagnostic Observation Schedule (ADOS), DSM or International Classification of Diseases (ICD) criteria.

Interest

Studies were eligible if they investigated CBT for anxiety in individuals with ASD, regardless of format (e.g., online or face-to-face, individual or group), duration, or number of sessions. Both adapted and standard CBT interventions were included to address our secondary aim of comparing the effectiveness of different adaptations, as well as comparing adapted CBT to standard CBT. Studies were excluded if the interventions were not primarily based on CBT principles.

Context

Eligible studies had to include participants with an anxiety disorder diagnosed by a psychiatrist, psychologist, or other trained clinician or participants who met clinical cut-off scores on a clinical measure of anxiety at baseline.

Other

To ensure that a broad range of evidence was captured in this review, primary research of any study design could be included. However, case series were excluded to uphold the validity of our findings. Systematic reviews, studies using secondary data, grey literature, commentaries, theoretical papers, or studies that did not directly investigate an intervention were excluded. While research could be conducted in any country, only those published in English were included due to limited resources in translating papers.

Search strategy

Searches were conducted using five electronic databases, EMBASE, MEDLINE, PsycINFO, PubMed and Web of Science. Search terms were generated by referring to the search strategies from related systematic reviews as well as through consulting with librarians and experts in the field. This ensured an extensive and relevant search strategy. The final search included synonyms for four concepts: *autism spectrum disorder, young people, anxiety,* and *cognitive behavioural therapy.* For each concept, synonymous terms were linked by using the 'OR' Boolean Operator and all concepts were combined using the 'AND' Boolean Operator. Search strategies included free-text and medical subject headings (MeSH) terms that were adapted according to each database. Likewise, truncation symbols were used to include terms with different endings or spellings. Searches were then limited to English language. The full search strategy is shown in Appendix 1. The final search was conducted on 1st December 2023.

Study selection

All search results were imported into Zotero (2023), and duplicates were removed. All titles and abstracts were first screened by one independent reviewer (TU) using the inclusion and exclusion criteria. A randomly selected 20% of records were screened by a second independent reviewer (SS). This process was then repeated with the remaining articles by screening the full texts. Any discrepancy was discussed and resolved with the research team.

Data extraction

A data extraction table was used to record key information on authors, year of publication, country of origin, sample size, demographic characteristics, CBT programme, format, number of sessions, follow-up time, measures of anxiety, and informants. One independent reviewer (TU) completed data extraction for all studies with a second independent reviewer (SS) completing this process for a randomly selected 20% of the studies to compare agreement level.

Data on the adaptations to CBT and the main study findings were also extracted. Although only empirical studies were included in the review, if these studies used a specific CBT programme or manual, we referred to these manuals to gather comprehensive detail on the adaptations used. The information extracted from studies and any corresponding manuals included adaptations to therapy structure, format, content, practical adjustments, aids and materials, involvement of support networks (e.g., parents, teachers), and other relevant adjustments for ASD. This data was then used in the synthesis stage. This process was completed by one reviewer (TU).

Data synthesis

A narrative synthesis was used to summarise the data. A narrative synthesis includes a systematic summary of phenomena to enable a deeper understanding of the processes involved (Snilstveit, Oliver & Vojtkova, 2012). For this reason, a narrative synthesis was appropriate in reviewing the methods of CBT and providing a comprehensive understanding of the adaptations used in the studies. In completing data synthesis, we used validated guidelines from Popay et al. (2006) from the Economic and Social Research Council (ESRC) framework. This ensured that we followed established practice when synthesising data.

One reviewer (TU) completed the narrative synthesis. First, studies were grouped based on the different types of adaptations used. Key details of each adaptation, which were gathered during the data extraction stage, were tabulated and organised. We then compared findings across all studies to identify similarities and differences in these adaptations before they were categorised following critical discussion with a second reviewer (SS).

Quality Assessment

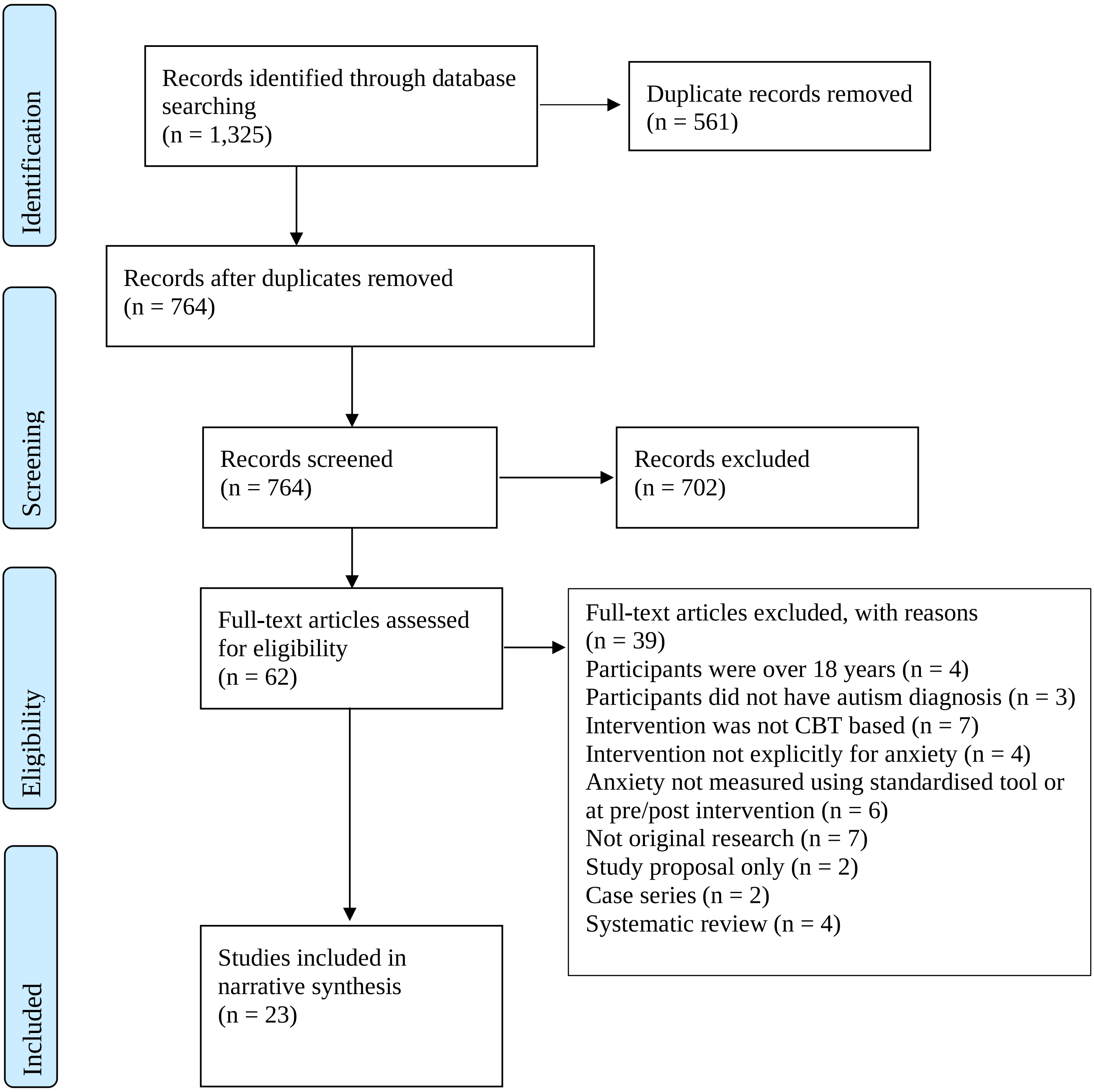
Quality assessment was completed using the Evaluation of Public Health Practice Projects (EPHPP; 2010) which is a standardised evaluation tool. The EPHPP evaluates eight methodological categories including selection bias, study design, confounders, blinding, data collection practices, withdrawals and dropouts, intervention integrity, and analysis which each receive a mark of “strong,” “moderate” or “weak” depending on quality. An overall global rating is calculated based on the first six methodological categories (excluding intervention integrity and analysis). The quality assessment was completed by two independent reviewers (TU and SS) for all included papers. There was a high level of agreement between the two reviewers, with only one study requiring further discussion with the research team. All studies were given equal weighting, regardless of quality, when synthesising the findings.

RESULTS

Study selection

An overview of the study selection process is shown in Figure 1. The search produced 1,325 studies with 764 remaining following deduplication. The titles and abstracts were then screened resulting in 702 papers being excluded. Full text screening was completed for the remaining 62 papers and a further 39 papers were excluded. Therefore, 23 papers were eligible for the review and were included in the narrative synthesis.

Figure 1. PRISMA (2009) flow diagram describing the study selection process



Study characteristics

The study characteristics of the included studies are summarised in Table 1. Studies were published between 2007 and 2020 in various high-income countries. This included the USA (n = 11), UK (n = 4), Australia (n = 4), Singapore (n = 2), Denmark (n = 1), Netherlands (n = 1). A total of 1,100 participants were included in the studies. All studies had a majority of male participants, and three studies only had male participants completing the CBT intervention (Clarke et al., 2017; McNally Keehn et al., 2013; Reaven et al., 2012). One study did not report participant gender profiles (Ooi et al., 2008). One study examined children in early childhood (aged between 4-6 years; Cook et al., 2019) and the remaining 22 studies examined youths from middle childhood to adolescence (aged between 7-18 years).

The studies either used standard CBT, adapted CBT, or CBT programmes/manuals specifically designed for individuals with ASD: adapted CBT (n = 3), Exploring Feelings (Attwood, 2004; n = 3), Behavioural Interventions for Anxiety in Children with Autism (BIACA; Wood & Drahota, 2005; n = 4), Building Confidence CBT Program (Wood & Mcleod, 2008; n = 2), Cool Kids Program (Lyneham, Abbott, Wignall, & Rapee, 2003; n = 2), Facing your fears (Reaven et al., 2011; n = 2), Multimodal Anxiety and Social Skill Intervention for adolescents with ASD (MASSI; White et al., 2010; n = 2), BRAVE-ONLINE Program (Spence et al., 2008; n = 1), Coping Cat (Kendall & Hedtke, 2006; n = 1), Discussing + Doing + Daring (Bodden et al., 2008; n = 1), Fun with Feelings Program (Cook et al., 2019; n = 1) One study adapted CBT by using more than one program including Coping Cat and Exploring Feelings (Sung et al., 2011). A full list of these CBT manuals as well as which studies used them is shown in Appendix 2. Interventions were delivered in a group format (n = 8), individually (n = 4), combined individual and family (n = 7), combined individual and group (n = 2) or as a multifamily group (n = 2). The number of sessions ranged from 6 to 32 weekly sessions with 16 sessions being the modal number.

The adaptations, any CBT programmes/manuals used and the main findings from each study is shown in Appendix 3. Of the 23 included studies, 17 reported that the CBT intervention treatment was effective, either showing significant within-group effects pre- to post-treatment or being superior to a comparator (WL, treatment as usual or standard CBT). Four of the included studies showed no significant improvement in anxiety levels nor superiority over a comparison treatment. Finally, two studies showed mixed results. Ooi et al. (2008) found significantly reduced child and teacher-reported anxiety, however, parent reports showed increased anxiety. Wood et al. (2009) found significant group differences between CBT and WL in the reduction of anxiety symptoms reported by clinicians and parents, however, no significant group differences in child-reported anxiety. The secondary aim of our study was to compare different adaptations and adapted CBT to standard CBT to determine which shows the greatest treatment effect. However, there was an insufficient number of studies investigating each CBT programme meaning it was not feasible to conduct such analyses and this limitation is further explored in our discussion.

Quality assessment

Quality assessment ratings for the studies are presented in Table 2. We scored 15 of the 23 studies to be of strong methodological quality. Seven papers were found to be of moderate methodological quality. Reasons for this was that assessors were not always blind to the allocation status of participants and participants were aware of the research question (Chalfant et al., 2007; Cook et al., 2019; Fuji et al., 2013; Soronoff et al., 2005; van Steensel & Bögels 2015; Wood et al., 2009). Luxford et al. (2017) did not report on any differences between treatment groups hence it was unclear if the authors controlled for confounding variables. One study (Ooi et al., 2008) had weak methodological quality as bias was detected in both blinding and controlling for confounding variables.

Table 1. Characteristics of included studies

Author (year); Country	Sample Size	Gender (% Males)	Age	Program name; Format	Number of sessions	Follow-up	Measures of Anxiety	Informants
Chalfant et al. (2007); Australia	47, Intervention: N = 28; control (wait list): N = 19	Total sample—74%	8-13; (M=10.57)	Cool Kids program; Group;	12 Sessions over 9 weeks, 3 monthly boosters	None reported	SCAS-P, SCAS- C, RMAS	Parent, Teacher and Child
Clarke et al. (2017); UK	28, Intervention: N = 14; control (wait list): N = 14	Total sample - 85.7%; intervention - 76.2%; control—95.2%	11-14; Intervention M=12.64 control M=12.86	Exploring feelings; Group	6 weekly sessions	6-8 weeks post-intervention	SCAS-P, SCAS- C	Parent and Child
Conaughton et al. (2017); Australia	38, Intervention: N = 20; control (wait list): N = 18	Total sample - 85.7%; intervention - 76.2%; control—95.2%	8-12; Intervention M=9.81; Control M=9.67	BRAVE-ONLINE program (Standard CBT for Anxiety); Individual	10 child and 6 parent sessions, two booster sessions at 1- and 3-months post-intervention. 10-14 weeks	3-month follow-up for treatment group only	SCAS-P, SCAS-C	Parent and Child

Cook et al. (2019); Australia	31, Intervention: N = 14; control (wait list): N = 17	"Total sample - 87.1%, intervention - 85.7%; control - 88.2%"	4-6; Intervention M=5.50; Control M=5.42	Fun with Feelings program; Group	9 weekly sessions with 1 month booster	3-month follow-up for treatment group only	CBCL, DASS, PSI, PSOC	Parent
Fuji et al. (2013); USA	12, Intervention: N = 7; Control: N = 5	"Total sample - 75%, intervention - 71.4%; control - 80%"	7=11 Intervention M=8.7; Control M=9.0	Building Confidence CBT Program; Parent and Child	32 weekly sessions	None reported	ADIS-C/P, CSR	Parent, Child and Clinician
Kilburn et al. (2020); Denmark	49, Intervention: N = 25; control (wait list): N = 24	Total sample—57%; intervention—60%; control—54%	8-14; Intervention M=11.99; Control M=10.68	Cool Kids program; Individual with two parent sessions	16 weekly sessions	2-month follow-up for treatment group only	ADIS-C/P, SCAS-P, SCAS-C	Parent, Child and Clinician
Luxford et al. (2017); UK	35, Intervention: N = 18; control (wait list): N = 17	Total sample—89%	11-16; Total sample M= 13.20	Exploring feelings; Group	6 weekly sessions	6-week follow-up	SAS*, SAS**, SWQ	Parent, Teacher and Child
Maskey et al. (2019); UK	N = 32, Intervention: n = 16; control	Total sample—78.1%;	8-14; Intervention M=10.84;	Simplified CBT technique and VR sessions;	1 CBT session, 4 VR sessions	6-month follow-up	SCAS-P, SCAS-C	Parent and Child

	(wait list): n = 16	intervention— 81.3%; control— 75%"	Control M=10.75	Individual				
McConachie et al. (2014) UK	N = 31, Intervention: n = 17; control (delayed therapy): n = 14	Intervention— 88%; control—87%	9-13; Intervention M =11.70; Control M=11.80	Exploring feelings; Group	7 Sessions	6 and 9 months after baseline	ADIS, SCAS-P, SCAS-C	Parent, Child and Clinician
McNally Keehn et al. (2013) USA	N = 22, Intervention: n = 12; control (wait list): n = 10	Intervention— 100%; control—90%	8-14; Intervention M=11.65; Control M=11.02	Coping Cat program; Individual with two parent sessions	16 weekly sessions	2-month follow-up for treatment group only	ADIS, SCAS-P, SCAS-C	Parent, Child and Clinician
Murphy et al., 2017	N = 36, Intervention: n = 17; control (counselling): n = 19	Intervention— 59%; control—63%	12-18; Intervention M=14.94; Control M=15.56	MASSI; Individual and group	12 individual and 5 group sessions	12-week follow-up	ADIS-C, CASIanx	Parent and Clinician
Ooi et al. (2008) Singapore	N = 6	Not reported	9-13; Total sample M=11.50	CBT; Group	16 weekly sessions	None reported	ACAS, SCAS-P, SCAS-C	Parent, Child and Teacher

Reaven et al. (2012) USA	N = 43, Intervention: n = 20; control: n = 23	Intervention—100%; control—92.3%	7-14; Intervention M=10.48; Control M=10.42	Facing Your Fears; Multifamily Group	12 sessions over 12-16 weeks	None reported	ADIS-P	Clinician
Soronoff et al. (2005) Australia	N = 71, 1st Intervention: n = 23; 2nd Intervention 2: n = 25; control (wait list) = 23	1st Intervention – 87%; 2nd intervention 2–88%; control— 87%	10-12; 1st Intervention M=10.56; 2nd Intervention M=10.54; Control M=10.75	CBT; Group	6 weekly sessions	6-week follow-up	SCAS-P	Parent
Storch et al. (2013) USA	N = 33, Intervention: n = 22; control (TAU): n = 21	Intervention—79.2%; control—81%	7-11; Intervention M= 8.83; Control M=8.95	BIACA; Individual and family	16 weekly sessions	3-month follow-up for treatment group only	PARS, ADIS-C/P, MASC-P, RCMAS	Parent, Child and Clinician
Storch et al. (2015) USA	N = 31, Intervention: n = 16; control (TAU): n = 15	Intervention—75%; control—86.7%	11-16; Intervention M=12.75; Control M=12.73	BIACA; Individual and family	16 weekly sessions	1-month follow-up for treatment group only	PARS, ADIS-C/P, RCDAS, MASC-P	Parent, Child and Clinician

Sung et al. (2011) Singapore	N = 64, Intervention: n = 33; Control (Social recreational program): n = 31	Total sample —94%; intervention —94%; control —94%	9-16; Intervention M=11.33; Control M=11.09	Various adaptations based on the Coping Cat program, Exploring feelings and anxiety management programs from the Child Guidance Clinic and Autism Resource Centre; Group	16 weekly sessions	3- and 6-months follow-up	SCAS-C	Child
van Steensel & Bögels (2015) Netherlands	N = 174, ASD group: n = 79; non-ASD: n = 95	ASD group - 78.37%	7-18; Total sample M=11.76	Discussing + Doing + Daring (standard CBT for anxiety); Individual and Family	12 sessions	3 months, 1 year and 2-year follow-up	ADIS-C/P, SCARED-71	Parent and Child
Walsh et al. (2018) USA	N = 80	Total sample - 83.8%	8-14; Total sample M=11.11	Facing Your Fears; Multifamily group	14 weekly sessions	None reported	SCARED	Parent and Child
White et al. (2013) USA	N = 25, Intervention: n = 13; control (wait list): n = 12	Total sample—77%; intervention—	12-17; Intervention M= 14.17;	MASSI; Individual and group	13 individual and 7 group sessions over 14 weeks	None reported	PARS, CASI-Anx	Parent and Clinician

		73%; control—80%	Control M= 15.0					
Wood et al. (2009) USA	N = 36, Intervention: n = 14; control (wait list): n = 22	Intervention—71%; control—65%	7-11; Intervention M=9.18; Control M=9.22	Building Confidence CBT program; Individual	16 weekly sessions	None reported	ADIS-CSR, MASC-P, MASC-C	Parent, Child and Clinician
Wood et al. (2015) USA	N = 33, Intervention: n = 19; control (wait list): n = 14	Total sample—70%; intervention—68%; control—71%	11-15; Intervention M=12.40; Control M=12.20	BIACA; Individual and Family	16 weekly sessions	1-month follow-up	ADIS-C/P, MASC-P, PARS, RCADS	Parent, Child and Clinician
Wood et al. (2020) USA	N = 143, Standard CBT (coping cat) : n = 66; Adapted Intervention (BIACA) 2: n = 59; control (wait list) = 18	Coping CAT—82%; BIACA—72%; control—100%"	7-13; Total sample M=9.9	Standard CBT (Coping cat) vs Adapted Intervention (BIACA); Individual	16 weekly sessions	6-Month follow-up	PARS, CBCLAnx	Parent and Clinician

ACAS = Asian Children Anxiety Scale; ADIS = Anxiety Disorders Interview Schedule; ADIS-C/P = Anxiety Disorders Interview Schedule – Child and Parent Version**;** CBCL = The Child Behaviour Checklist**;** CSR = Clinical Severity Rating**;** MASC-C= Multidimensional Anxiety Scale for Children – Child Version; MASC- P= Multidimensional Anxiety Scale for Children **-** Parent Version**;** PARS = Paediatric Anxiety Rating Scale**;** RCADS = Revised Child Anxiety and

Depression Scale; RCMAS = Revised Children’s Manifest Anxiety Scale**;** SAS* = School Anxiety Scale**;** SAS** = Spence Anxiety Scale; SCARED = Screen for Child Anxiety and Related Emotional Disorders; SCAS-C = Spence Children’s Anxiety Scale; SCAS-P = Spence Children’s Anxiety Scale – Parent Report; SDQ = Strength and Difficulties Questionnaire

Table 2. Quality assessment of the included studies using the EPHPP

Study Author	Selection Bias	Study Design	Confounders	Blinding	Data Collection Methods	Withdrawals and Drop-outs	Global Rating
Chalfant et al., 2007	Moderate	Strong	Strong	Weak	Strong	Moderate	**Moderate**
Clarke et al., 2017	Moderate	Strong	Strong	Moderate	Strong	Strong	**Strong**
Conaughton et al., 2017	Strong	Strong	Strong	Moderate	Strong	Strong	**Strong**
Cook et al., 2019	Moderate	Strong	Strong	Weak	Strong	Strong	**Moderate**
Fuji et al., 2013	Moderate	Strong	Strong	Weak	Strong	Moderate	**Moderate**
Kilburn et al., 2020	Moderate	Strong	Strong	Strong	Strong	Strong	**Strong**
Luxford et al., 2017	Moderate	Strong	Weak	Moderate	Strong	Strong	**Moderate**
Maskey et al., 2019	Moderate	Strong	Strong	Moderate	Strong	Strong	**Strong**
McConachie et al., 2014	Moderate	Strong	Strong	Strong	Strong	Strong	**Strong**
McNally Keehn et al., 2013	Moderate	Strong	Strong	Moderate	Strong	Strong	**Strong**
Murphy et al., 2017	Moderate	Strong	Strong	Moderate	Strong	Strong	**Strong**
Ooi et al., 2008	Moderate	Moderate	Weak	Weak	Strong	Strong	**Weak**
Reaven et al., 2012	Moderate	Strong	Strong	Moderate	Strong	Strong	**Strong**
Soronoff et al., 2005	Moderate	Strong	Strong	Weak	Strong	Strong	**Moderate**
Storch et al., 2013	Moderate	Strong	Strong	Moderate	Strong	Strong	**Strong**
Storch et al., 2015	Moderate	Strong	Strong	Moderate	Strong	Strong	**Strong**

Sung et al., 2011	Moderate	Strong	Strong	Strong	Strong	Strong	**Strong**
van Steensel & Bögels 2015	Moderate	Moderate	Strong	Weak	Strong	Moderate	**Moderate**
Walsh et al., 2018	Moderate	Moderate	Strong	Moderate	Strong	Strong	**Strong**
White et al., 2013	Moderate	Strong	Strong	Moderate	Strong	Strong	**Strong**
Wood et al., 2009	Strong	Strong	Strong	Weak	Strong	Strong	**Moderate**
Wood et al., 2015	Moderate	Strong	Strong	Moderate	Strong	Strong	**Strong**
Wood et al., 2020	Moderate	Strong	Strong	Moderate	Strong	Strong	**Strong**

Adaptations to CBT for autistic children and young people with anxiety

Affective education

Affective education was a key adaptation that was outlined by nine studies. The main aim of affective education is to support clients in learning about emotions, using emotions and identifying emotions in themselves and other people (Luxford et al., 2017; McConachie et al., 2014). Studies highlighted supporting clients with global recognition of emotions, that is, through facial expressions, body language, physiological reactions, thinking, feeling, behaviour and speech (Clarke et al., 2017; Ooi et al., 2008; Sung et al., 2011). Studies using Attwood's Exploring Feelings program (2004) highlighted the use of 'spot the message' games and resources to identify ambiguous emotion cues (e.g., a furrowed brow could mean anger or confusion). This includes learning to draw on other cues to identify emotions more accurately and exploring the meaning behind emotions. Other studies highlighted using client's special interests, for example, a particular cartoon character that children are interested in can be drawn upon with the character's feelings serving as a point of discussion to better understand emotions (Wood et al., 2009).

Following emotion recognition training, studies highlighted supporting clients in understanding levels of emotion intensity. The use of an emotion 'thermometer' was indicated by studies to support clients in identifying and measuring levels of emotional expression (Clarke et al., 2017; Soronoff et al., 2005; Walsh et al., 2018). Pictures or words were used to display or describe different levels of emotional expression respectively and could be placed at different points on this thermometer. The thermometer also acts to help children understand early warning signs by recognising rising emotional arousal which then requires intervention. Therapists are encouraged to mirror language and gestures used by clients for a shared understanding of emotion recognition (Soronoff et al., 2005; Clarke, 2017).

Some studies placed emphasis on psychoeducation surrounding anxiety such as explaining the fight or flight response to perceived danger. Children and young people can explore thinking, affect and the physiological responses to anxiety such as increasing heart rate, perspiration, breathing, muscle tone and perception (Clarke et al., 2017; McConachie et al., 2014; Walsh et al., 2018). Emphasis was placed on concrete anxiety cues such as physiological responses and changes in speech and behaviour to support the explicit learning needs of autistic children (Soronoff et al., 2005; Sung et al., 2011).

Use of aids

Fourteen studies highlighted the use of aids in adapting CBT for autistic children and young people. Visual aids were used to reduce the use of abstract thinking and increase concrete learning (Chalfant et al., 2007; Cook et al., 2019; Kilburn et al., 2020; Maskey et al., 2019; Ooi et al., 2008; Sung et al., 2011). This included the use of structured worksheets, emotion thermometers, pictorial anxiety scales, drawing a collage and storyboards or comic strips to outline an anxiety episode.

Visual aids were also adapted for age and development. For example, younger children benefited from puppet storytelling or picture story books when conceptualising anxiety and eliciting thoughts, feelings, knowledge, and intentions from the client (Cook et al., 2019). Older children and adolescents were often provided with activity workbooks, and structured worksheets. Within these materials multiple choice lists, written examples of core concepts and hands-on activities were utilised (Luxford et al., 2017; Reaven et al., 2012; Walsh et al., 2018).

White et al. (2013) noted the importance of working with a client’s strengths when using aids. For example, clients with stronger visual-spatial abilities may benefit from the use of imagery (such as cartoon characters or symbols) as this can cue them to utilise therapeutic techniques. Alternatively, for clients who rely on language for learning new concepts, therapists explored and used shared terms or worked creatively with clients to generate new words to describe certain emotions (White et al., 2013; Reaven et al., 2012).

Parent and teacher input

Nine studies described parent or teacher input to enhance the quality of the CBT intervention through practising skills and consolidating learning. Parents often received concurrent CBT manuals which could include affective education with a specific focus on anxiety, support with social difficulties (see also social skills training below), support with relaxation, cognitive restructuring exercises to use at home, graded exposure, parent management training and relapse prevention plans (Chalfant et al., 2007; McNally Keehn et al., 2013; Murphy et al., 2017; Soronoff et al., 2005; Storch et al., 2013; 2015). Parent modules were also used to facilitate learning between sessions or as homework, for example, parents were taught how to set up exposure tasks and use record sheets and diaries (Storch et al., 2013; 2015; Wood et al., 2015; 2020). For younger autistic children, greater emphasis was placed on parent-mediated interventions with parents instructed on CBT strategies which they can teach their children (Cook et al., 2019).

Studies highlighted the role of parents in promoting participation through the use of coaching and encouragement (McNally Keehn et al., 2013; Reaven et al., 2012). Two studies that used the Facing Your Fears programme (Reaven et al., 2011) involved joint parent and child sessions. They highlighted how parents were used as powerful resources to cue children to engage in positive coping strategies and socialise them to treatment models (Reaven et al., 2012; Walsh et al., 2018).

Teachers were similarly included in interventions by providing clients with affective education, teaching CBT skills, social coaching, and encouraging them to use strategies at school (Fuji et al., 2012; Wood et al., 2015). In one study, separate consultation sessions with teachers were used to support exposure therapy by enabling exposure tasks to take place at school (e.g., facilitating conversations with peers for those with social anxiety; Wood et al., 2015).

Social skills training

Thirteen studies discussed the use of social coaching and skills training. This adaptation included teaching friendship skills to children such as giving compliments, turn-taking, recognising others' emotions, developing peer relationships, and hosting social get-togethers (Fuji et al., 2012; Walsh et al., 2018; Wood et al., 2009; 2020). Often this was paired with a social component by supporting clients to discover how other people can be a source of support in restoring positive feelings through conversations to reassure, gestures or affection (Soronoff et al., 2005). This learning could be achieved through in vivo social exposure with on-site (e.g., at school) social coaching which encourages reflective discussion and perspective-taking (Storch et al., 2013; 2015; Wood et al., 2020). Learning social skills was also achieved through modelling to demonstrate what can be done in social situations before allowing the client to practice themselves (Murphey et al., 2017; White et al., 2013). In two studies using MASSI (White et al., 2010) therapists would model a skill by stating explicitly what they were doing and feeling (e.g., "I feel nervous about how someone will respond but I will say ‘hello’ as I know that’s how I should greet someone;”) for clients to then practice themselves (Murphey et al., 2017; White et al., 2013).

Different studies also brought in peers, parents and/or teachers for skills training. Buddy programs were established in two studies where teachers were consulted to identify similarly aged children who are accepting and caring and therefore able to support the client in participating in activities. Clients were encouraged to practice the skills gained in training sessions before practising and navigating social situations with this trusted peer for generalisation to non-clinical settings (Fuji et al., 2012; Wood et al., 2015). Likewise, some joint parent and child interventions taught social skills to both parties whilst also encouraging parents to practice such skills at home, school, and in public using reward systems to consolidate learning (Fuji et al., 2012).

Social stories were used to support understanding of social situations and manage emotions. Clients were told to write out a recent anxiety-provoking event and then work with the therapist to think about what strategies can be used at each stage of the story to manage anxiety (Clarke et al., 2017; Ooi et al., 2008; Soronoff et al., 2005; Sung et al., 2011). Social stories aimed to manage emotions and create an ‘antidote’ for difficult or noxious thoughts whereby the strategies learned can be applied to real-life situations (Soronoff et al., 2005).

Special interests and rewards

Nine studies highlighted the importance of incorporating interests, strengths, and rewards. Interests were used imaginatively by therapists to address difficulties in attention and motivation when introducing therapeutic concepts (e.g., using a particular cartoon character to identify feelings and thoughts) and as rewards (by providing access to a preferred stimulus; Maskey et al., 2019; Reaven et al., 2012; Soronoff et al., 2005; Wood et al., 2015). Some studies suggested that expanding on clients’ strengths, talents and interests during every session can strengthen rapport while enhancing communication, socialisation to the CBT model, and engagement (McNally et al., 2013; Reaven et al., 2012). An example used by Soronoff et al., (2005) was using a metaphor of the client as a ‘scientist’ or ‘astronaut’ who explored different planets of emotions as many young boys with ASD have a special interest in science. In other studies, interests were used initially to build client rapport and engagement but were later suppressed; therapists would carefully work with the client to decrease conversations about the specific interest (and stereotypies) to shift attention to more socially acceptable topics for skills training and exposure tasks (Storch et al., 2013; Wood et al., 2009).

Use of rewards could also be used to promote engagement and compliance with treatment. Target behaviours were reinforced with rewards comprehensively at home, at school and within the community (through parent and/or teacher involvement; Wood et al., 2020). Likewise, during exposure tasks, as clients progressed up the hierarchy of feared situations, rewards were provided for attempting each situation (Fuji et al., 2012).

Feedback and practice

Seven studies outlined the importance of practice and feedback as a modification to CBT. The studies using the MASSI programme (White et al., 2010) highlighted that feedback should be immediate, direct, and specific as opposed to general and delayed feedback (Murphy et al., 2013; White et al., 2013). The provision of age-appropriate and individualised feedback as to why a specific behaviour is good or bad is useful as it provides clients with a rationale (White et al., 2023). The MASSI program (White et al., 2010) also emphasises corrective and positive social learning experiences to ensure clients feel safe to try new skills in a supportive environment and, therefore, maximise engagement with materials. Feedback was also provided in group sessions whereby participants could share strategies that work well when navigating anxiety-provoking situations and offer supportive yet constructive feedback (Murphy et al., 2013; Soronoff et al., 2005).

Studies also emphasised repetition and practice of in-session tasks, particularly exposure tasks to consolidate learning and generalisation. Exposure tasks were encouraged as homework assignments to allow for practice at home, during playdates, at school and within the community with some studies encouraging parent feedback immediately following these tasks (Chalfant et al., 2007; Cook et al., 2019; McConachie et al., 2014; Reaven et al., 2019). Families were also asked to make daily diary entries to record these practices and outcomes which can also be reviewed in session for further feedback (Chalfant et al., 2007).

Concrete or simplified tasks

Six studies also emphasised the use of explicit behavioural tasks over abstract ones (e.g., cognitive strategies) to accommodate the learning style of autistic youths. In some studies, more time was spent on relaxation, role-plays, and exposure tasks as they use concrete and literal terms as well as explicit learning that promotes engagement for autistic children (Chalfant et al., 2007; Cook et al., 2019; McNally Keehn et al., 2013). Behavioural experiments were encouraged but with particular emphasis on documenting learning on written or visual materials to consolidate learning (Chalfant et al., 2007; McNally Keehn et al., 2013).

When using cognitive interventions such as restructuring, studies highlighted the importance of using client strengths. For example, clients who can conceptualise thoughts and feelings may readily engage with cognitive restructuring whereas others may benefit from simplifying such tasks by using worksheets or lists of alternative thoughts as prompts (Chalfant et al., 2007; Kilburn et al., 2020). Alternatively, when using cognitive tasks, initial focus on tangible physical sensations or behaviours was used before eliciting cognitions to promote socialisation to the model (Cook et al., 2019; Clarke et al., 2017; Reaven et al., 2012). Cognitive tasks could also be broken down or made highly structured and in a predictable format (Cook et al., 2019).

DISCUSSION

Main findings and implications

This systematic review and narrative synthesis aimed to comprehensively examine the adaptations to CBT for autistic children and young people with anxiety. Across 23 studies (n = 1,100), we identified seven themes with key details of how adaptations were delivered. To our knowledge, this is the first review to synthesise the methods used to deliver CBT to autistic youths. Therefore, this study addressed a major gap in research and our findings can be used to inform clinical practice. As a secondary aim, we also aimed to compare the effectiveness of different adaptations and compare adapted CBT to standard CBT. However, due to an insufficient number of studies investigating each adapted manual or each adaptation, we could not conduct such analyses. Consequently, while our review provides a comprehensive summary of key adaptations, we cannot make any definitive conclusions on their effectiveness.

Our findings highlight the use of practical modifications for CBT to promote engagement with therapy content. Research has shown that adjustment of materials through concrete, visual and structured tactics can enhance engagement (Scarpa, White & Attwood, 2016; Sze and Wood, 2007; 2008). Reaven and Hepburn (2003) report a toolbox method for CBT for anxiety whereby children were asked to draw tools with cognitive strategies that can be used at times of heightened anxiety. Concurring with our findings, this study also utilised social stories to recognise and manage difficult emotions (Reaven & Hepburn, 2003). Previous research has also pointed to a reduction in abstract language, instead favouring concrete and visual concepts: Sze and Wood (2007) achieved this by using thought bubbles, cartoon scenarios, and therapist-client role plays to implement emotion recognition and cognitive strategies. In a case study by Lehmkuhl et al., (2008), the therapist used a list of emotion cues and coping statements for a child with OCD to endorse and “rules” to identify when anxiety was increasing. Concrete and literal concepts when discussing OCD symptoms and reward systems during exposure tasks were also used. These adaptations allowed the child to identify emotions and obsessive thoughts effectively to therefore manage symptoms (Lehmkuhl et al., 2008). Collectively, our findings alongside the existing evidence-base demonstrate the role of concrete visual tactics when conducting CBT for autistic youths. Accordingly, therapy can accommodate children’s literal thinking style, their understanding of emotions, therapeutic concepts, and management of anxiety.

Appropriate use of special interests was also identified in our review. Similarly, Moore and Davis (2010) argue that while interests may be excessive, if integrated into therapy in a controlled manner, they can increase motivation and engagement from a young person. Previous research has also highlighted the importance of using preferred language over traditional CBT concepts, special characters, and talents to engage materials (Raven & Hepburn, 2003; Sze & Wood, 2008) In a second case study by Sze and Wood (2008) the therapists used the child’s interests in early sessions before phasing these out by using Socratic questioning. This allowed the child to recognise when to appropriately engage with interests to enhance social interactions and in vivo practice. The findings illustrate the importance of a delicate balance between promoting interests for therapeutic benefit and a client-centred approach, whilst being mindful not to reinforce fixated interests.

Education and skills training are important findings when considering the cognitive profile of those with ASD. Individuals with ASD often have difficulty with attributing mental states to others, known as the Theory of Mind (ToM; Baron-Cohen and Jolliffe, 1997; Rutherford, Baron-Cohen and Wheelwright, 2002) and both expressed emotion and recognition of social cues may be poorly recognised or displayed (Anderson & Moris, 2006). Studies have shown that emotional literacy can improve with teaching (Bauminger, 2002; Sofronoff & Attwood, 2003). Likewise, social skills training has been shown to enhance the quality of response to social cues, reciprocal communication, and interpersonal skills (Beaumont, 2017). It has also been shown to contribute to a reduction in social anxiety symptoms by systematically exposing participants to social situations and equipping them with useful strategies for social functioning (Beaumont, 2017). Therefore, social training may be an important component that should occupy more time in early CBT sessions.

Our synthesis also highlighted consolidating learning from CBT through themes of parent and teacher input as well as the use of feedback and practice. The findings concur with previous research including Perihan and colleagues' review (2019) which found that treatment effect size was the largest for CBT interventions that included parent involvement. Parent-mediated CBT, where content is delivered to parents who then act as 'therapists' to their children has also shown promise in research by demonstrating a moderate effect size in reducing anxiety symptoms compared to WL conditions (Cartwright-Hatton, McNally Keehn et al., 2013; Cartwright-Hatton et. al., 2011). This supports the hypothesis that family participation can play a significant role in CBT for autistic youths. This may be attributed to the fact that parents of children and young people with ASD play an important role in their child's routine, their interests and in understanding their communication needs (Moore & Davis, 2010). Parents can also encourage the generalisation of skills learned in CBT through at-home practice. For this reason, parent involvement can be used to increase client buy-in and enhance socialisation to the CBT model.

Parent and teacher involvement was also highlighted in facilitating feedback and practice in a range of settings including the home, at school, with peers, and in the community. The importance of feedback and practice has been highlighted in research (Spain & Happé; 2019; Sze and Wood, 2007; 2008). This is particularly important considering the cognitive profile of individuals with ASD, namely rigidity in thinking and fixated interests. Feedback and practice can enable clients to consolidate skills in a range of situations to promote generalisation which may otherwise be difficult to instil for this population (Sze and Wood, 2007). This is also important considering that CBT for anxiety requires practice of exposure tasks and behavioural experiments as the main mechanisms for learning.

Further consideration should be given to the nature of adaptations for autistic children and young people compared to typically developing children, specifically whether the adaptations identified in this review are unique to autistic youths. For instance, adaptations such as visual aids, special interests, and parent involvement are also used with typically developing children, which complicates the task of determining whether these interventions are uniquely tailored for autistic youth or are broadly applicable (Walters et al., 2016). However, Walters et al. (2016) note that the application of visual aids and skills training is further tailored to address the heightened sensory and cognitive processing needs of autistic youth. Similarly, special interests are a key feature in autistic youth and can significantly enhance engagement, though their use may be less pronounced in typically developing children (Rogers & Vismara, 2008). Our review also highlighted that the use of special interests may need to be gradually reduced in autistic youths due to their susceptibility to fixation, whereas this issue is less common among typically developing children. The involvement of parents and teachers, as well as affective education, also requires a more nuanced application for autistic youths to address their unique emotional and social processing challenges (Lai et al., 2014). While some adaptations overlap, distinguishing their specific application for autistic youths from those used with typically developing children requires further research. Future studies should investigate how these adaptations are distinctively applied to autistic individuals compared to typically developing children to enhance our understanding of their contextual relevance and effectiveness (Lai et al., 2014; Sharma et al., 2021).

The findings have important implications for training and may be used to inform guidelines for clinical practice. While recommended practice has been put forward when delivering CBT for autistic populations, there has yet to be an established set of guidelines. In a review of the evidence for typically developing children and adolescents, commonly used techniques included exposure, relaxation, cognitive restructuring, and modelling (Chorpita & Daleiden, 2009). It may be useful to combine these findings with our own to create a specific set of guidelines for working with anxiety in autistic populations.

Limitations

Our review was limited by the selection of studies for inclusion. We did not perform hand searches and excluded unpublished and grey literature. While we did refer to the treatment manuals that were used in the included studies, there may be other manuals within the grey literature that we omitted from the review. The exclusion of grey literature may have resulted in a narrower scope, as unpublished studies, manuals, commentaries and reports may contain detailed descriptions of innovative adaptations that are not present in peer-reviewed literature.

Consequently, our synthesis may not fully capture the range and variety of CBT adaptations for autistic youths.

Furthermore, we excluded studies not published in English. This may explain why all the studies included were from predominantly Western and high-income countries. This introduces issues surrounding the generalisability of our findings, specifically how applicable findings are to those from low- and middle-income countries. Most studies included in this review did not report participant ethnicity, it is therefore difficult to gauge how applicable our findings are to different ethnic groups. Research has demonstrated that individuals from racially minoritised groups in Western countries such as the US and UK experience barriers to accessing quality mental health care, particularly those with intellectual disabilities and ASD (Robertson et al., 2019; Prajapati & Liebling, 2020). As such, it is unclear how useful the adaptations we have reported on are for those from minoritised ethnic groups. Our review was also limited in how far we differentiated adaptations by age group. Only one study included participants from early childhood (Cook et al., 2019) and all other studies included children from a wide age range from middle childhood to adolescence of which adaptations were not specified by age group. This is an important limitation considering that autism presentation and adaptations for therapy will differ largely according to age and development. Likewise, most of the included studies had a majority or only male participants. However, a growing body of research highlights gender specificity in ASD presentation including phenotypes, psychiatric co-morbidities and camouflaging (Green et al., 2019). Therefore, there are key implications for treatment that this review did not examine. There is a clear research need to develop adaptations for autistic populations which hold in mind these different demographic characteristics.

While our quality assessment highlighted seven studies of moderate quality and one of weak quality, all studies were included in the synthesis with equal weighting. As such, the inclusion of lower quality studies may have introduced bias to our findings.

A narrative synthesis was selected for our review as it provides a nuanced understanding of phenomena and rich insights into patterns across studies (Popay et al., 2006). However, it is worth noting the alternative methods of synthesising adaptations and the limitations of our chosen approach. For example, a framework synthesis uses predefined categories or frameworks to systematically compare and synthesise qualitative data across studies

(Brunton et al., 2019). A major strength of a framework synthesis over a narrative synthesis is the highly structured nature which enhances reliability and reproducibility. Likewise, the use of an initial framework for coding data helps to reduce bias as all relevant data is considered systematically. With less structure, a narrative synthesis can be more subjective and less transparent in data interpretation (Popay et al., 2006). Further, a framework synthesis provides a granular or detailed analysis to identify specific themes and patterns that may be overlooked in a narrative synthesis.

While a range of adaptations were identified it should be noted that research has primarily focused on individuals with high functioning autism. It has yet to be examined whether these modifications are useful for those with low-functioning ASD or those with co-morbid intellectual disabilities. Children with higher functioning ASD may find it easier to engage with adapted CBT than those with lower functioning ASD. This is an important caveat when standardising adapted CBT and is an important consideration for clinicians when adapting their practice with children across the spectrum.

While the primary aim of our study was to synthesise the adaptations to CBT, we were unable to complete our secondary aim to compare the effectiveness of these different adaptations or compare them against standard CBT to determine which is associated with better outcomes. This was due to an insufficient number of studies investigating each type of adaptation or CBT manual. This is an important limitation of our review as without determining efficacy we cannot conclude the usefulness of adapted CBT for this population. Indeed, of the included studies, two investigated standard (non-adapted) CBT and demonstrated effectiveness in reducing anxiety (Conaughton et al., 2017; Van Steensel et al., 2012). This highlights a significant limitation in our study: without comparative data for adapted CBT, we cannot ascertain if the adaptations offer any incremental improvements or superiority over standard CBT. Consequently, the lack of such comparative analysis restricts our ability to make definitive conclusions about the effectiveness of adapted CBT, which is essential for evidence-based practice and the advancement of modified therapeutic approaches.

Future Research

Future research should examine the effectiveness of adapted CBT compared to standard CBT. As a gold standard design, RCTs which compare the two interventions will enable high-quality evidence and robust conclusions. Such research is crucial to determine whether adaptations provide additional benefits over established treatment and therefore their value in clinical practice. Furthermore, within our review we were unable to compare the effectiveness of different adaptations and future research should aim to dismantle and examine adaptations to determine which are the most valuable. This may be challenging as interventions often involve multiple adaptations, and it can be difficult to tease apart which leads to the greatest therapeutic effect. A dismantling design involves investigating components of an intervention separately and in combination to uncover the relative usefulness of various components (Resick et al., 2010). For example, an RCT with multiple arms can involve participants randomly assigned to different groups, receiving standard CBT or adapted CBT with specific adaptations (e.g., sensory adjustments, visual supports, skills training) removed. Data can be analysed to compare anxiety reduction across adaptation groups to determine the relative effectiveness of each adaptation. Findings will address the gap in our present review by highlighting which adaptations, if any, are the most effective and can be used to guide clinicians in implementing the most beneficial adaptations that optimise therapeutic outcomes.

With our findings demonstrating key adaptations for CBT for anxiety for children and young people with autism, health service researchers should now work to monitor and examine the implementation of these adaptations. Additionally, future research should extend to examining adaptations for minoritised groups, including racially minoritised communities, young and teenage girls, and those with psychiatric co-morbidities. Addressing these gaps is crucial, as research has shown that standard CBT may not fully meet the needs of these diverse groups. Culturally and contextually adapted interventions can improve engagement by addressing specific barriers and needs that are specific to these different groups (Griner & Smith, 2006; Liu et al., 2024). Hence, targeted studies can explore how these adaptations can be optimised for minoritised groups to ensure equitable and effective treatment.

Conclusions

Our findings highlighted the importance of practical adaptations, education and skills training as well as parent and teacher feedback when adapting CBT for autistic children and young people. However, the effectiveness of such adapted practice is still to be determined. Future research should compare adapted and standard CBT to underpin the true value of adapted practice. Future research should also dismantle the effectiveness of different adaptations to uncover the key ingredients to therapy as well as examine adaptations for diverse groups.

Collectively, these findings can be used to inform clinical practice and are a crucial starting point for the development of therapy guidelines. This may enhance both access and quality of psychological interventions for young autistic people.

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APPENDICES

Appendix 1. Search Strategy

Search terms:
exp Autism Spectrum Disorders/ OR autis*.mp OR ASD.mp. OR asperger*.mp. OR pervasive developmental disorder.mp.

AND

child*.mp. OR infant* OR young person*.mp. OR young people*.mp. OR teen*.mp. OR youth*.mp. OR adolescen*.mp.

AND

exp Cognitive Behavior Therapy/ OR cognitive behavio*.mp. OR CBT.mp.

AND

exp Anxiety Disorders/ OR exp Anxiety/ OR Anxiety.mp. OR anxi*.mp. OR Panic* OR GAD OR Phobi* OR Agoraphobi*

Limits:
English Language

Appendix 2: List of CBT programmes/manuals used in studies

CBT Programmes/Manuals	Used in which studies
Behavioural Interventions for Anxiety in Children with Autism (BIACA; Wood & Drahota, 2005)	Storch et al., 2013; Storch et al., 2015; Wood et al., 2015; Wood et al., 2020
BRAVE-ONLINE Program (Standard CBT; Spence et al., 2008)	Conaughton et al., 2017
Building Confidence CBT Program (Wood & Mcleod, 2008)	Fuji et al., 2013; Wood et al., 2009
Cool Kids Program (Lyneham, Abbott, Wignall, & Rapee, 2003)	Chalfant et al., 2007; Kilburn et al., 2020
Coping Cat (Kendall & Hedtke, 2006)	McNally Keehn et al., 2013
Exploring Feelings (Attwood, 2004)	Clarke et al., 2017; Luxford et al., 2017; McConachie et al., 2014
Discussing + Doing + Daring (Bodden et al., 2008)	van Steensel & Bögels 2015
Facing your fears (Reaven et al., 2011)	Reaven et al., 2012; Walsh et al., 2018
Fun with Feelings Program (Cook et al., 2019)	Cook et al., 2019
Multimodal Anxiety and Social Skill Intervention for adolescents with ASD (MASSI; White et al., 2010)	Murphy et al., 2017; White et al., 2013
Combined manuals: Coping Cat (Kendall & Hedtke, 2006) and Exploring Feelings (Attwood, 2004)	Sung et al., 2011

Appendix 3. Study adaptations and main findings from included studies

Study	Was a CBT programme or manual used?	Adaptations for ASD	Main findings
Chalfant et al., 2007	Cool Kids Program	- Greater number of sessions over a longer period (6 months) - Visual aids and structured worksheets - More sessions on relaxation and coping - Use of exposure tasks over cognitive tasks - Simplified cognitive tasks, e.g., use of worksheets and alternative thoughts list. - Generalisation and practice of learning using homework exposure tasks - Parent psychoeducation and training on CBT exercises	- Post-treatment: 71.4% of participants in the treatment condition no longer met diagnostic criteria for an anxiety disorder compared to 0% on the WL. Significantly greater reduction in parent-reported anxiety (SCAS-P: t(1,45) = 14.687, p < .01); self-reported anxiety (SCAS-C: t(1,45) = 11.246, p < .01; RCMAS: t(1,45) = 11.246, p < .01) and teacher reported emotional difficulties (SDQ: t(1,45) = 9.415, p < .01) for treatment compared to WL
Clarke et al., 2017	Exploring feelings	- Initial focus on client strengths and special talents - Affective education between physiology and emotions - Use of games such as “spot the message” for ambiguous emotion cues. - Relaxation techniques - Thinking tools including perspective taking, imagination and acting - Role-Playing and Social Stories - Simplified Language and Concrete Examples	- Post-treatment: Significantly greater reduction in child-reported anxiety (SCAS-C: F(2,24) = 54.8, p = <.001, d = .72), and parent-reported anxiety (SCAS-P F(2,24) = 28.3, p = .001, d = .69) for the treatment condition over WL. - Follow-up: Significantly greater reduction in child-reported anxiety (SCAS-C: F(2,24) = 13.9, p = .003, d = .31) and parent-reported anxiety (SCAS-P F(2,24) = 10.5, p = .003, d = .38) - Client and parent interviews reported improvements in coping, reduced avoidance and increased use of problem-solving.
Conaughton et al., 2017	BRAVE ONLINE (Standard CBT)	- None	- Post-treatment: Significantly greater reduction in self-reported (SCAS-C: F(1, 32.49) = 4.83, p=.035) and parent reported anxiety (SCAS-P F(1, 36.25) =4.49, p=.041) for the treatment condition over WL. - Follow-up: Treatment condition showed a significant reduction in the number of anxiety diagnoses (*d* = 1.91), self-reported

			(SCAS-C: *d* = 1.28) and parent-reported (SCAS=P: *d* = 1.03) anxiety symptoms
Cook et al., 2019	Fun with Feelings Program	Coaching parents to deliver CBT with adaptations including: • Affective education and emotion regulation training for young children with ASD • Visual aids and activity books • Highly structured, simple/predictable activities that are short in duration. • Emphasis on practical strategies to reinforce skills that parents can integrate into daily routines. • Very gradual and controlled exposure to fears with parental support	• Post-treatment: No treatment effects were found for child or parent-rated outcomes. • Pre-treatment to 3-month follow-up: Children in the treatment group showed a reduction in internalising (CBCL-Internalising: Hedge's *g* = -0.69). No other significant group differences were found.
Fuji et al., 2013	Building Confidence CBT Program	• Highly structured with a clear and predictable format • Use of different visual aids, e.g., charts, diagrams, visual schedules • Use of straightforward, concrete language and examples to explain cognitive and behavioural concepts • Opportunity for behavioural rehearsal and role-playing to practice new skills and strategies. • Friendship skills and social coaching • Comprehensive reward system with daily privileges and long-term incentives • Parents and teacher involvement to support the child's therapy process, reinforcing strategies at home and school. • Peer buddy programme to encourage positive interactions	• Post-treatment: 71.4% of those in the treatment group no longer met the criteria for an anxiety disorder compared to 0% for TAU. Significantly greater reduction in clinical severity rating for the treatment group compared to TAU (CSR: F(2, 12) = 6.62, p = .017)
Kilburn et al., 2020	Cool Kids Program	• Simplified and concrete cognitive restructuring exercises or exposure tasks • Relaxation techniques • Greater number of sessions over a longer period (6 months)	• Post-treatment: 30% of children in the treatment condition no longer met the criteria for their primary anxiety diagnosis (ADIS-C/P: *d* = 1.05) compared to 10% for the WL condition (ADIS-C/P: *d* = .71). 5% of children in the treatment condition were free of all anxiety diagnoses (ADIS-C/P: *d* = .59)

		• Visual aids and structured worksheets • More sessions on relaxation and coping • Use of exposure tasks over cognitive tasks • Simplified cognitive tasks, e.g., use of worksheets and alternative thoughts list. • Generalisation and practice of learning using homework exposure tasks • Parent psychoeducation and training on CBT exercises	compared to 0% for WL condition (ADIS-C/P: *d* = .21). But no statistically significant differences between treatment and WL on primary anxiety diagnosis or number of anxiety diagnoses • Follow up: those free from primary diagnosis (ADIS-C/P) was 47.2% at post-treatment and 52.8% at FU suggesting treatment maintenance
Luxford et al., 2017	Exploring Feelings	• Highly structured • Written lists and concepts • Affective education between physiology and emotions • Relaxation techniques • Thinking tools inc. perspective taking, imagination and acting • Role-playing and social stories • Simplified language and concrete examples	• Post-treatment and follow-up: Intervention group showed improved anxiety symptoms on parent report (SAS*: F(2, 24) = 16.74, p < 0.001, n^2p = 0.41), self-report (SWQ: F(2,64) = 4.45, p = 0.015, n^2p = 0.12) and Teacher report (SAS**: F (2,33) = 5.23, p < 0.01, n^2p = 0.14) • Marginal increased effects of teacher-reported social responsiveness.
Maskey et al., 2019	No	• Affective education • Visual aids such as the use of feelings thermometer. • Relaxation techniques, including tactile and visual cues appropriate for ASD profile	• Post-treatment: 25% treatment group were classified as responders compared to no control group children. • Follow-up: 38% of treatment group children were classified as responders six months after treatment, compared with no control group children.
McConachie et al., 2014	Exploring feelings	• Longer sessions with breaks • Highly structured, organised workbooks • Affective education between physiology and emotions • Use of games such as "spot the message" for ambiguous emotion cues. • Relaxation techniques • Thinking tools inc. perspective taking, imagination and acting • Role-playing and social stories • Simplified language and concrete examples	• Intervention had a high-fidelity rate with an attendance rate of 91%. • Post-treatment: significantly greater reduction in anxiety for the treatment group compared to WL for child report (χ2(1) = 7.43, p = .006) and parent report (χ2(1) = 4.01, p = .045) • Positive feedback from qualitative interviews, including learning CBT skills, feeling accepted and the impact of anxiety levels.

McNally Keehn et al., 2013	Coping Cat Program	• Highly structured and predictable format • Written and visual aids to accommodate each client's learning style. • Focus on self-monitoring progress through visual worksheets • Repeated practice and role-playing to consolidate learning. • Incorporate specific interests to engage clients. • Use of sensory objects or proactive movement breaks • For clients with rigid thinking, more focus on behavioural components (e.g. relaxation, role-plays, exposure tasks) • Simplified cognitive restructuring by using concrete language, visual tools, and useful examples. • Involvement of parent/careers to practice strategies and encourage in real world	• Post-treatment: Significantly greater reduction in anxiety symptoms for clients in the treatment group compared to WL in child report (SCAS-C: F(1, 19) = 3.10, p = .09, Cohen's d = .51) and parent report (SCAS-P: F(1, 20) = 6.31, p = .02, Cohen's d = 1.17) • Follow-up: Treatment effects were largely maintained at a for parent report (SCAS-P t(10) = 4.57, p = .001, Cohen's d = 1.38) but not significant for child report (SCAS-C: t(10) =-.87, p = .40, Cohen's d = .27)
Murphy et al., 2017	MASSI	• Visual supports, writing and drawing activities, and other approaches (e.g., drama, tactile reminders) • Very gradual exposure to feared stimulus with regular practice and feedback. • Parent involvement as "coaches" in CBT • Parents practice tasks at home and in the real world. • Focus on peer relationships to maintain social skills. • Use of special interests to engage clients with therapy • Simplify cognitive restructuring by using concrete, visual and logical methods and tailoring them to the client's cognitive profile	• Post-treatment: The treatment intervention and TAU had no significant differences on any anxiety measure apart from separation anxiety where treatment was superior (CSR: F(1, 35) = 7.77, p = .01) • Follow-up: The treatment intervention and TAU had no significant differences on any anxiety measure.
Ooi et al., 2008	No	• Visual aids • Social stories to understand anxiety presentation and management. • Affective education, emotion regulation	• Post-treatment: significantly reduced anxiety on child report (SCAS-C: t(5) = 1.88; p = 0.12; d = 0.36) and teacher report (ACAS t(5) = 0.55; p = 0.61; d = 0.28). However, parent report showed higher levels of anxiety (SCAS-P: t(5) = -0.56; p =

			0.60, d = -0.23). None of these differences shows statistical significance due to the small sample size.
Reaven et al., 2012	Facing Your Fears	• Clear, predictable structured sessions • Affective education • Emotion regulation skills • Multi-sensory activities for expression of emotions • Token reinforcement program for target behaviours. • Visual aids and social stories • Worksheets with multiple choices and written examples of core concepts • Focus on strengths and interests to engage. • Very gradual and controlled exposure to fears with repeated practice • Video modelling and video activity to enhance learning	• Post-treatment: significantly greater reduction in anxiety severity ratings for treatment compared to TAU (ADIS-P: F(1, 40) = 8.11, p = .007). Significant group reduction in GAD diagnoses for the treatment group compared to TAU (ADIS-P: X^2(1,42) = 6.64, p = .01; d = .85) Significantly greater improvement in the treatment group compared to TAU (ADIS-P: X^2(1,42) = 9.07, p = .003, d = 1.03)
Soronoff et al., 2005	No	• Incorporate special interests and characters to understand feelings. • Thermometer as a visual cue for emotions • Parents trained as co-therapists, practice tasks at home and in the real world. • Use of social tools e.g., using peers and modelling to restore positive feelings	• Post-treatment: Significantly greater reduction in parent-reported anxiety levels for the two treatment conditions (child only or parent and child) compared to WL (SCAS-P: F(4,158) = 9.16, p < .0001). Parent and child treatment was more efficacious than child alone.
Storch et al., 2013	BIACA	• Focus on behavioural interventions tailored to address anxiety in autistic children. • Behavioural reinforcement through the use of special interests and rewards • Visual aids such as visual schedules, social stories, and pictorial prompts • Structured and predictable environment	• Post-treatment: Children in the CBT group were treatment responders relative to TAU (75% versus 14%, p < .01, d = 1.59). 38% of children in the CBT group achieved clinical remission versus 5% of those in the TAU arm (p = .01, d = 1.37). • Follow-up: no significant changes from post-treatment among the treatment group, suggesting treatment effects were maintained.

		• Parent modules to facilitate between session tasks, reward systems and engagement. • Additional focus on coping strategies	
Storch et al., 2015	BIACA	• Focus on behavioural interventions tailored to address anxiety in autistic children. • Behavioural reinforcement through the use of special interests and rewards • Visual aids such as visual schedules, social stories, and pictorial prompts • Structured and predictable environment • Parent modules to facilitate between session tasks, reward systems and engagement. • Additional modules for social and adaptive skills, motivation and coping strategies	• Post-treatment: Significantly greater improvement for the treatment group compared to TAU in clinician-rated anxiety levels (PARS: d = 0.79), ADIS: d = 1.30), and CGI Severity rating: d = 0.94). • 68.8% of the treatment group were responders compared to 26.7% of those in the TAU group (P = .03) • Follow-up: No significant differences were observed for clinician-rated treatment response (P = .27) or diagnostic remission (P = .79), suggesting that treatment effects maintained.
Sung et al., 2011	Combined programmes: Coping Cat program & Exploring feelings	• Highly structured and predictable format • Affective education and emotion regulation • Written and visual aids accommodated to each client's learning style. • Focus on self-monitoring progress through visual worksheets • Repeated practice and role-playing to consolidate learning. • Incorporate specific interests to engage clients. • For clients with rigid thinking, more focus on behavioural components (e.g. relaxation, role-plays, exposure tasks) • Simplified cognitive restructuring by using concrete language, visual tools, and useful examples. • Involvement of parent/careers to practice strategies and encourage in the real world. • Use of social stories to understand how anxiety presents and can be managed	• Post-treatment: Both CBT treatment and the Social Relational program (comparison group) showed significantly lower levels of generalized anxiety (SCAS-C: F(3, 129) = 3.28, p = .03, n2 = .06) and total anxiety symptoms (SCAS-C: F(3, 124) = 3.03, p = .04, n2 = .06). • Follow-up: significantly lower anxiety symptoms for both groups but no significant group differences, suggesting treatment effects maintained.

van Steensel & Bögels 2015	Discussing + Doing + Daring (standard CBT)	• None	• Post-treatment: CBT was significantly more effective than waitlist for treating anxiety disorders (ADIS-C/P: d = -1.45) and anxiety symptoms (SCARED: d = -0.48) • At 2 years follow-up, 61% of the children with ASD were free of their primary anxiety disorder.
Walsh et al., 2018	Facing You Fears	• Clear, predictable structured sessions • Affective education • Emotion regulation skills • Multi-sensory activities for expression of emotions • Visual aids and social stories • Worksheets with multiple choices and written examples of core concepts • Focus on strengths and interests to engage. • Very gradual and controlled exposure to fears with repeated practice • Concrete tasks (breathing, coping strategies, physiological responses) • Parent input to encourage and cue children to interventions. • Video modelling and video activity to enhance learning	• Post-treatment: Clients and parents rated treatment as more acceptable than the comparator, and higher exposure acceptability ratings were significantly predictive of lower youth anxiety levels post-treatment (F(2,43) = 4.33, p = .019) • Parents and clients rated the acceptability of the intervention as high. However, clinicians rated acceptability as lower than other conditions.
White et al., 2013	MASSI	• Work with client strengths e.g., visual-spatial skills. • Practice and age-appropriate individualised feedback. • Very gradual exposure to feared stimulus with regular practice and feedback. • Parent involvement as "coaches" in CBT • Parents practice tasks at home and in the real world. • Focus on peer relationships to maintain social skills. • Social skills training through modelling	• Post-treatment: Non-significant within-group improvement in anxiety (*d*=.55). No significant difference for anxiety symptoms between treatment and WL (CASI-Anx: p= .31). • Treatment was acceptable to families, high level of client adherence, and therapist fidelity.

		• Use of special interests to engage clients with therapy • Simplify cognitive restructuring by using concrete, visual and logical methods and tailoring then to the client's cognitive profile	
Wood et al., 2009	Building Confidence CBT program	• Highly structured with a clear and predictable format • Use of different visual aids, e.g., charts, diagrams, visual schedules • Use of straightforward, concrete language and examples to explain cognitive and behavioural concepts • Opportunity for behavioural rehearsal and role-playing to practice new skills and strategies. • Friendship skills and social coaching • Comprehensive reward system with daily privileges and long-term incentives • Incorporate interests to start before suppression approach is used in later sessions. • Peer buddy programme to encourage positive interactions	• Post treatment: Significantly greater reduction for clinician reported (ADIS-C/P: F1,33) = 54.19, $p < .0001$, ES = 2.46) and parent reported (MASC-P: F(1,32) = 19.50, $p < .0001$, ES = 1.23) anxiety for treatment condition compared to WL. However, non-significant group difference for child-reported anxiety (MASC-C: F (1,33) = .03, p = .87, ES = .03) • Follow-up: Treatment effects were maintained for parent-reported anxiety (MASC-P: t(9) = .37, p = .72). No significant difference post-treatment to follow-up on child-reported anxiety (MASC-C: t(9) = –.72, p = .49)
Wood et al., 2015	BIACA	• Focus on behavioural interventions tailored to address anxiety in autistic children. • Behavioural reinforcement through the use of special interests and rewards • Visual aids such as visual schedules, social stories, and pictorial prompts • Structured and predictable environment • Parent modules to facilitate between session tasks, reward systems and engagement. • Teacher consultations to support exposure therapy	• Post-treatment: significantly greater reduction in clinician-reported anxiety (PARS: p =.04, ES = 0.74) for the treatment group compared to WL. Only marginally significant reduction in anxiety on parent reports (MASC-P: p = .10, ES = 0.59) for the treatment group compared to WL. Non-significant difference in child-reported anxiety (RCADS: p =.93, ES = 0.02). 79% of the CBT group met Clinical Global Impressions–Improvement scale criteria for positive treatment response at post-treatment, compared to only 28.6% of the waitlist group. • Follow-up: No significant change in clinician-reported anxiety findings (PARS: p = .79, ES = 0.07) suggesting maintained treatment. Significant reduction in anxiety at follow-up in child report (RCADS: t(8) = 2.86, p = .02, ES = 0.95) and parent

			report (MASC-P: t(7) = 2.10, p =.07, ES = .74) suggesting treatment maintenance and improvement.
Wood et al., 2020	Standard CBT vs Adapted Intervention (BIACA)	Adapted intervention group included: • Focus on behavioural interventions tailored to address anxiety in autistic children. • Behavioural reinforcement through the use of special interests and rewards • Visual aids such as visual schedules, social stories, and pictorial prompts • Structured and Predictable Environment • Parent modules to facilitate between session tasks, reward systems and engagement. • Hosting peers to improve social skills and confidence.	• Post-treatment: significantly greater reduction in clinician-rated anxiety for the treatment group compared to standard-CBT (PARS: Mean [SD] 2.13 [0.91] vs 2.43 [0.70], P = .04) and TAU (2.93 [0.59], P < .001). Significantly greater reduction in parent-reported anxiety for the treatment group compared to TAU (CAIS: d = 0.75, P = .003) but not significantly different to standard-CBT. • Both CBT conditions achieved higher rates of positive treatment response than TAU (BIACA = 92.4%; Coping Cat = 81.0%; TAU = 11.1%; P < .001) • Follow-up: Treatment group had a significantly greater reduction in clinician-rated anxiety than both standard-CBT and TAU (PARS: standard-CBT: d = 0.63, P = .04 and TAU: d = 1.69, P < .001)

Chapter II

Empirical Project

Virtual reality assisted cognitive behavioural therapy for social anxiety in autistic adolescents: A case series

Supervisors: Dr Matthew Hollocks, Dr Lucia Valmaggia, Professor Emily Simonoff
Contributor: Lucy Adams

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ABSTRACT

BACKGROUND: Autism Spectrum Disorder (ASD) is a lifelong neurodevelopmental disorder that includes difficulties with social interaction and communication, alongside restricted interests and repetitive behaviours. Autistic adolescents commonly experience social anxiety, with cognitive behavioural therapy (CBT) recommended as a first-line intervention. Virtual reality (VR) assisted CBT can be used to augment therapy by immersing individuals into social situations with means of practising therapy skills.

AIMS: This case series aimed to develop and examine the feasibility and acceptability of a novel VR-CBT intervention designed to support autistic adolescents with social anxiety.

METHOD: A 12-session VR-CBT intervention was developed with reference to existing models, the literature base, and stakeholder involvement. The VR component was used to develop formulation, conduct exposure tasks and behavioural experiments, and practice CBT skills. Participants with ASD and social anxiety were recruited from Child and Adolescent Mental Health Services to complete this intervention. Feasibility was assessed by examining recruitment rate, retention rate and adherence to therapy. Acceptability was assessed by conducting semi-structured interviews with participants post-intervention to understand their experience of using VR and areas for improvement. Change in anxiety symptoms and goal attainment was assessed from pre-intervention, post-intervention to 6-week follow-up.

RESULTS: Nine participants were approached with six commencing the study for a 67% recruitment rate. With one drop-out, five participants completed the intervention for an 83% retention rate. An average of 11 sessions were attended by the five participants. All participants stated that they would recommend the intervention to other autistic adolescents with social anxiety. The themes from the qualitative interviews included engagement with VR, its appropriateness for autistic adolescents, using VR to socialise to the CBT model and areas for improving the intervention. 40% of participants showed a reliable improvement in anxiety symptoms and 60% of participants showed successful goal attainment at post-intervention and follow-up.

CONCLUSIONS: The current study tentatively presents findings that VR-CBT is feasible, and acceptable for autistic individuals experiencing social anxiety. However, the limitations of a case series including a lack of control over variables and limited generalisability are noted. Future research should involve a robust pilot study followed by a randomised control trial to investigate the efficacy of the intervention before examining implementation in NHS settings.

KEYWORDS: Virtual Reality; VR-CBT; Autism spectrum disorder; social anxiety

Terminology for Autism Spectrum Disorders

There are a range of different views surrounding the correct terminology when referring to autism spectrum disorders. There is debate as to whether language is used for identity-first (i.e., autistic person, neurodiverse people) or person-first (i.e., person with autism, people who are neurodiverse). However, according to the National Autism Society, the autistic community advocates for identity-first language as it highlights how individuals perceive the world (Bradshaw et al., 2021). Therefore, for purposes of this thesis, identity-first language will be used whilst acknowledging different preferences for terminology.

INTRODUCTION

Autism spectrum disorder (ASD) is a lifelong neurodevelopmental condition that affects 1% of the UK population (Lombardo & Baron-Cohen, 2010). It is characterised in the Diagnostic and Statistical Manual of Mental Disorders (DSM-V; American Psychiatric Association; APA, 2013) as differences in social interaction and communication alongside a pattern of restrictive interests, repetitive behaviours and/or differences in sensory behaviours. While these differences should be present in early childhood, difficulties in functioning may not be present until demands exceed an individual's capacity (APA, 2013). Hence, recognition and diagnosis of ASD may occur in later childhood, adolescence and even adulthood for many individuals when their social demands increase (Happé & Frith, 2020).

ASD is understood to have a large genetic component with heritability estimates ranging from 40 to 80% (Chaste & Leboyer, 2012). Research has highlighted that individuals with an autistic sibling are at 50 times more likely to have ASD themselves (Szatmari et al., 1998). However, growing research has highlighted the role of environmental risk, namely epigenetics, vulnerabilities during the perinatal period and immunity disturbance (Chaste & Leboyer, 2012). As such, the role of gene-environment interaction has been proposed in the presentation of ASD (Glasson et al., 2004). ASD has also been reported to affect three times as many males as females (Loomes et al., 2017), however, under-recognition in females is acknowledged (Happé & Frith, 2020).

There is an increasing number of autistic individuals diagnosed with comorbid mental health difficulties (Simonoff et al., 2008). Over two-thirds of autistic people report experiencing one comorbid mental health difficulty and around 50% of autistic people report having multiple comorbidities (Lai, 2019). For autistic children and young people, there is a higher risk of mood and affective disorders compared to neurotypical populations (Ozsivadjian & Knott, 2011). While research has shown variable rates between ASD and co-occurring mental health difficulties, anxiety has been reported to be the most experienced affective disorder. Lai and colleagues (2019) reported a pooled prevalence of ASD and co-occurring anxiety at 20% while Van Steensel et al. (2011) reported that 39.6% of autistic children and young people experience an anxiety disorder. It is thought that co-occurring mental health difficulties can have a larger impact on an individual's wellbeing than ASD itself (Van Steensel et al., 2012). Anxiety in autistic children and young people is linked to impairments in adaptive functioning, school non-attendance and underperformance, reduced social wellbeing and early mortality (Fujii et al., 2012; Joshi, Petty & Wozniak, 2010; Reaven et al., 2011). Likewise, higher levels of anxiety in autistic individuals are thought to amplify autistic symptoms such as social communication difficulties, sensory difficulties, and ritualistic behaviours (White et al., 2009). It is also linked to the development of depression and increases the risk of self-harm and suicide in autistic young people (Cassidy et al., 2018).

With the increasing number of individuals diagnosed with ASD and anxiety disorders, there is growing pressure on mental health services in the UK (Walters et al., 2016). Frequent referrals and readmission to services are seen in those with mental health co-morbidities (Matson & Nebel-Schwalm 2007). It is also reported that one in ten children and young people who are referred to Child and Adolescent Mental Health Services (CAMHS) have a diagnosis of ASD (Wistow and Barnes 2009). Poor service provision can have a profound impact on the prognosis of the young person and the wellbeing of the entire family. With consequences for young people, families, and demands on services, this necessitates high-quality and cost-effective treatments for comorbid mental health conditions for autistic youths (Donoghue et al., 2011; Walters et al., 2016).

One of the most common types of anxiety experienced by autistic youths is social anxiety. Social anxiety is characterised by a marked fear of evaluation from others in one or more social situations where the fear is out of proportion with the actual social threat (APA, 2013). Social anxiety also leads to avoidance and clinically significant distress or impairment in social, occupational, or other areas of functioning (APA, 2023). These symptoms are persistent and present for at least six months (APA, 2013). Social anxiety is one of the most common anxiety disorders with a lifetime prevalence reported at 12% (Kessler et al., 2005). For neurotypical adolescents, the prevalence of social anxiety is reported to be between 5.7% and 12% (Aune, Nordahl & Beidel, 2022; Kessler et al., 2012). However, the prevalence is significantly higher for autistic adolescents at 29% to 57% (Bellini, 2006; Simonoff et al., 2008).

Clark and Wells' (1995) cognitive model of social anxiety has become the dominant treatment model in neurotypical populations and has a robust evidence base (Clark, 2001). The model outlines that when entering a social situation, focus will shift onto oneself with negative thoughts surrounding performance and self-focused attention. Internally generated information and sensory cues are relied on to evaluate social performance rather than external information. This can create catastrophic and disproportionately negative images of oneself including how one is perceived by others. Safety behaviours, such as escape, avoidance or rehearsal of social interactions, are used for temporary relief but maintain anxiety in the long term (Clark & Wells, 1995).

Traits of autism have been shown attune to the cognitive model and hence social anxiety presentation. Research has shown that autistic adults show enhanced interoceptive sensitivity and reduced interoceptive accuracy when asked to track their heartbeat compared to neurotypicals (Garfinkel et al., 2016). As such, it is thought that greater physiological arousal in autistic populations leads to increased self-focus thereby enhancing social anxiety symptoms (Bellini, 2004; Wood et al., 2021).

Likewise, cognitive mechanisms are thought to mediate the relationship between ASD and social anxiety. For example, autistic people show greater fear of negative evaluation which predicts greater attention to socially threatening stimuli (White et al., 2015). Likewise, autistic individuals have also shown greater attentional bias to threatening faces (Lei & Russell, 2020), and are more likely to interpret ambiguous social cues negatively (Hollocks et al., 2016). Social mediators have also been reported; difficulties in social communication with others mean that autistic youths are vulnerable to bullying, social isolation, and rejection to heighten an individual's perception of social danger and, in turn, increase the risk of social anxiety (Liu et al., 2021). This finding is particularly important for adolescents; this period places greater emphasis on peer relationships, school, and transition into adulthood thereby increasing demands, particularly social demands. Other research has shown that alexithymia (ability to identify and express one's own emotions) and difficulties with theory of mind (ability to understand others by attributing mental states to them; Baron-Cohen & Jolliffe, 1997) mean that autistic individuals are more likely to view their social skills negatively and have negative perceptions when interacting with others. In turn, this exacerbates their social communication difficulties (Bird et al., 2010; Spain et al., 2017). As such, a bidirectional relationship between ASD and social anxiety has been proposed, that is, social impairments lead to social anxiety and this anxiety can exacerbate social impairments (Montaser, 2023).

As a first-line treatment for social anxiety in adolescents, the National Institute of Health and Care Excellence (NICE, 2013) recommends cognitive behavioural therapy (CBT) based on Clark and Well's Model. CBT is a psychological therapy based on the idea that mood is influenced by thoughts, feelings and how we behave (Beck 1976). Evidence has highlighted that CBT for social anxiety in neurotypical youths is both successful and cost-effective (Leigh & Clark, 2016; Leigh et al., 2021; Wang et al., 2017). However, treatments for neurotypical populations are less likely to show effectiveness for autistic youths. The core features of ASD such as communication difficulties, impaired emotional literacy and concrete thinking may limit how far individuals can engage with standard CBT (Baron-Cohen et al., 1985; Simonoff et al., 2008).

As such, research has highlighted the importance of adapted CBT for autistic populations. A systematic review by Uddin et al (2024; submitted) highlighted key adaptations including visual support aids, use of concrete tasks without abstract concepts, affective education, social skills training, use of special interests, feedback and practice of tasks, and parent/teacher involvement. The effectiveness of adapted CBT for anxiety has been well established. Perihan et al. (2019) and Ung et al. (2014) both found moderate effect sizes in reducing anxiety symptoms in autistic youths. Other adaptations consider the sensory profiles of ASD: the environment of the therapy room can be modified via co-design with clients and their families to reduce overstimulation and ensure safe spaces (Stark et al., 2021). Given its effectiveness, adapted CBT has been recommended in NICE guidelines when working with autistic adolescents (NICE, 2013). However, it is worth noting that there remains a lack of research investigating adapted CBT for autistic adolescents with social anxiety specifically.

A novel technique that has gained considerable interest within clinical research is digital technology due to its flexibility and ability to personalise treatment (Adams, Valmaggia & Simonoff, 2021). Digital technologies include the use of electronic software and devices including mobile apps, internet-based approaches, wearables, and virtual reality (VR; Hollis et al., 2018). VR offers human-to-computer interactions via a visually generated environment with both auditory and visual cues (Wu et al., 2021). This multisensory immersion has the advantage of being engaging and safe for its user whilst allowing for timely feedback on performance (Carlin, Hoffman & Weghorst, 1997; Wu et al., 2021). VR is gaining increasing popularity in psychological interventions as an innovative form of technology that can be used alongside therapy to treat cognitive, emotional, and behavioural difficulties (Gregg & Tarrier, 2007; Thornhill-Miller & Dupont, 2016). VR has been widely used for specific phobias (e.g., fear of spiders or public speaking; Carlin et al., 1997; Wallach et al., 2009) and obsessive-compulsive disorder (OCD; Kim et al., 2009).

There is some preliminary research on the use of VR in autistic individuals with results showing promise. Like non-autistic populations, the research is specific to treating phobias and primarily in autistic adult populations (Maskey et al., 2019). Maskey et al. (2019) found that the use of VR during exposure sessions of CBT to treat phobias in autistic adults was both feasible and acceptable with treatment effects maintained at 6-month follow-up. The use of VR with autistic adolescents also shows promise with treatments targeting phobias (Maskey et al., 2014) and support with ASD such as emotion literacy and social communication difficulties (Bernardini et al., 2013; Ip et al., 2018).

It is thought that using VR to assist CBT (VR-CBT) is promising for autistic populations as it can overcome many barriers to standard treatment. First, autistic individuals experience difficulties with abstract thinking leading to difficulties in producing and controlling imaginal scenes. However, VR can create ecologically valid scenes with minimal abstract thinking or effort from its user (Low, Goddard & Melser, 2009). Second, when completing real world exposure tasks, autistic youths may find this highly anxiety-provoking due to the unpredictable nature of the stimuli which often leads to treatment disengagement (Maskey et al., 2019). VR can simulate real social scenarios and trigger anxiety in similar ways to standard exposure therapy whilst being controlled by the therapist to maintain safe limits (Eichenberg & Wolters, 2012). VR also has the added benefit of co-production with users to manipulate the level of intensity to a manageable level. Third, VR allows for repeated exposure to generated scenarios which can be reviewed for feedback. This is important considering the need for practice, feedback, and consolidated learning for autistic populations (Uddin et al., 2024; submitted).

Despite preliminary evidence of the effectiveness of VR in autistic adolescents, less is known about its role in treating anxiety disorders such as social anxiety. Given the prevalence and impact of social anxiety in autistic adolescents this is a research priority. Using VR to enhance CBT may increase the quality of this intervention and, hence, client engagement and fidelity.

Current study aims and objectives

This case series aimed to develop a novel and immersive VR environment that can be used alongside CBT to support autistic adolescents with social anxiety. The VR involved exposure tasks that simulate anxiety-provoking social situations. The primary objective of our study was to determine the feasibility and acceptability of this VR-CBT intervention. This includes investigating how well the study could recruit and retain participants and gathering feedback from participants about their experience of VR-CBT. The secondary objective of our study was to assess if the VR-CBT can reliably improve anxiety and support with goal attainment. The findings from this study can be used to refine and improve this intervention for use in a future pilot study and randomised controlled trial (RCT).

Our research questions are as follows:

Primary

1. Is the VR-CBT intervention feasible for participants? This includes determining the recruitment rate, retention rate, number of sessions attended, and number of homework tasks completed.
2. Is the VR-CBT intervention acceptable to participants? This includes determining whether the VR environments and scenarios are appropriate, immersive, realistic, and useful for participants and gaining feedback for the therapy protocol.

Secondary

1. Can the VR-CBT intervention reliably improve anxiety in participants?
2. Can the VR-CBT intervention support clients to achieve their goals for therapy?

METHOD

Ethical approval

Ethical approval (Appendix 1) was provided for this study by London - Dulwich Research Ethics Committee (IRAS ID: 272006, REC reference: 20/LO/0532) on behalf of the NHS Health Research Authority. Sponsorship was provided by King’s College London and South London and Maudsley NHS Foundation Trust (SLaM; Trust R&D Ref: R&D2023/013). This research study was hosted by SLaM.

Development of the VR scenarios

Development of this study began in 2019 as part of LA’s thesis for Doctor of Philosophy (PhD). LA completed the initial stages of the study design, ethics, and development of the virtual environment. However, due to the COVID-19 pandemic, the study had been postponed until early 2022 when TU joined the research team to complete intervention development and delivery, data collection, analysis, and write-up as part of the empirical project and thesis for Doctorate in Clinical Psychology (DClinPsy).

Initial development of the VR scenarios involved consultations with stakeholders and a review of the existing literature. The full report on this is provided by Adams and colleagues (2022) as part of PhD thesis submission.

Literature review

A literature review was conducted by researcher LA to underpin triggers and situations that provoke social anxiety, particularly for autistic adolescents. A range of situations were identified including negative social evaluation, interacting with others (particularly groups), public speaking (particularly impromptu or unprepared), being at the centre of attention, conversing with new people and social injustice. The literature review also highlighted moderators for anxiety for autistic youth such as hostility levels, crowdedness/busyness, and sensory stimulation including noise level. The full list of sources for different triggers, environments, and moderators is listed in Appendix 2.

Stakeholder involvement

Consultations from key stakeholders were conducted to ensure that the intervention was meaningful to the target population and therefore followed standards for patient and public involvement (PPI; Hoddinott et al., 2018; Rolfe et al., 2018) and NIHR recommendations (2020).

Clinicians (e.g., psychologists, care coordinators, and psychiatrists with experience with this client population; n = 17), were recruited from NHS clinics that specialise in working with ASD. The clinicians took part in a consultation group led by the researcher LA which included questions relating their opinions on the use of VR-CBT in autistic adolescents, how VR can be used in CBT, possible barriers, and the types of VR scenarios that would be appropriate for autistic adolescents.

Service users (n = 5) and their parents/guardians (n = 5) were approached by the clinicians who took part in the consultation group and consented to take part in an advisory group. These service users were a mix of males and females, had a diagnosis of ASD, were aged between 13-18 years, and had previously or were currently receiving CBT. Service users and their parents were met individually either face-to-face or via Microsoft Teams, based on their preference. Those who met the researchers face-to-face were provided with the option to engage with some basic VR environments or games/videos. They were then asked questions relating to their experience of VR ("How does it feel wearing it?') and its potential use in CBT ("What would encourage you to use VR?"; Adams et al., 2022). Service users and parents/guardians were asked about typical social situations that would be helpful to simulate in VR, triggers for social anxiety, and possible barriers to using VR-CBT.

All meetings were securely audio-recorded and deleted after being transcribed. Researcher LA transcribed, reviewed and compared each meeting to identify salient themes and to identify consensuses in opinions across service users, parents/guardians, and clinicians. Authors LA and JW checked which views corresponded with the existing literature which, in combination, would inform the development of the VR protocols. Themes from the stakeholder consultations are highlighted in Table 1.

Table 1. Main themes from stakeholder involvement

Predicted benefits	• Using VR to learn new skills, identify anxiety-provoking situations, and practice skills in these situations. • Enhancing assessment e.g., identifying triggers using VR to create a formulation model in a "real-time" manner which can otherwise be difficult to elicit in autistic populations using standard CBT. • Using VR as a communication aid as it provides a reference point for therapists to see their client's viewpoint. • VR is novel and engaging to promote buy-in from autistic youths who may disengage with standard CBT.
Predicted barriers and corresponding facilitators	• Over-reliance on VR scenarios over real-life exposure – treatment protocol to include setting real-life homework and real-life exposure tasks in sessions. • VR may be technically challenging to run – sufficient VR training and creating a user-friendly interface. • Participants should have sufficient emotional literacy training before starting VR to self-monitor levels of anxiety/emotion before levels become overwhelming.

	- Parent and clinician concerns that service users may find VR anxiety provoking – evidence shows a willingness from autistic individuals to engage in VR and protocols can be adapted so that participants are allowed to practice and become familiar with VR before engaging in full exposure. - Potential feeling of "cybersickness" or nausea, disorientation, and dizziness from VR – young people have shown a preference to use VR, agreeing that it is comfortable; VR scenarios to be short in duration with breaks offered and relaxing waiting rooms to reduce anxiety and cybersickness.
Recommended triggers and moderators for social anxiety	- Stakeholders and literature base highlighted triggers for anxiety which fell into three categories: 1. Approaching and conversing with others; 2. Experiencing perceived injustice. 3. Being at the centre of attention. - Different environments identified including school, public transport, and social gatherings. - Level of anxiety dependent on the format of the environment (e.g., one-to-one vs group conversations, low vs high predictability, hostile vs friendly interaction, busyness, noise level).
Recommendations for CBT	- Clinicians highlighted that there is no specific CBT manual for this client group (i.e., CBT for social anxiety in autistic adolescents). Other existing manuals (CBT for social anxiety in neurotypical adolescents) can be used to guide treatment with adaptations and the use of VR incorporated. - Key components of CBT for autistic adolescents are to be set in the protocol (e.g., psychoeducation, emotional literacy training) before VR exposure, although VR can be used to enhance these components. - Recommendation that treatment should be guided using client formulation. - Individualised treatment (e.g., selecting VR scenarios based on what a participant finds anxiety-provoking) and based on a participant's cognitive profile.

	- Bringing in parents/guardians into sessions to share learning from VR and practice exposure tasks in the real world between sessions/as homework.
Additional recommendations	- Therapist should have main control over the use of VR scenarios, but participants should voice which scenarios are relatable for them for individualised treatment. - Participants to control light and volume considering the sensory profile of ASD. - Clients may feel self-conscious using the VR headset to trigger performance anxiety. Limit who is in the therapy room to avoid multiple people watching.

The VR scenarios and environment

Following the literature review and consultations with stakeholders, six VR scenarios were created which would take place in one school environment. Only one environment was created given the limited time and resources of the project and for VR development. A school environment was selected as it is applicable to the target adolescent population and allows for a range of scenarios. Initially, the VR lab developer created the school environment including classrooms, hallways, toilets, and teachers' offices. Following this, written scripts for each scenario were created by TU. The scripts were then programmed into the virtual school environment by the lab developer before being tested by the researchers to amend any errors and finalise. An example of a classroom environment and an example of NPC dialogue is shown in Appendix 3.

The scenarios lasted around 3-5 minutes and involved the participant interacting with non-player characters (NPCs) to provoke anxiety. These scenarios (outlined in Table 2) included impromptu speech, asking a question, conversation with an authority figure, compliments/teasing, social invitations, and rule breaking. The scenarios could be presented with hostile, neutral and non-hostile (or friendly) interactions and could have noise level and crowdedness adjusted by the therapist. The therapist had main control over the VR and each scenario included a pause to bring in CBT skills (reflecting on thoughts, feelings and actions).

The VR used an Oculus Rift head-mounted display with headphones to project a 3D audio-visual interface to its user. The user could move around the VR environment by physically moving around or by using left- and right-handed controllers.

Table 2. Outline of VR scenarios including hostility level

Scenario	Description	NPC Hostility description	
A. Impromptu speech	Participant enters classroom and the teacher asks them to share what they did over the weekend.	Hostile: Mocking or dismissive response Non-hostile: Positive response, engaged comments	Hostile: Negative facial expressions, frowning, closed body posture, laughing, staring, or looking uninterested Neutral: Blank expression, neutral body posture, looks at participant intermittently Non-hostile: Smiling, nodding, open body language, eye contact without staring, uplifted tone
B. Asking a question	Participant needs to ask a classmate where the school library is.	Hostile: dismissive and mocking response Non-hostile: Kindly answers the participant	
C. Conversation with an authority figure	Teacher calls participant to their office to speak to them.	Hostile: Teacher tells participants off for being late to class Non-hostile: Teacher commends participant for their hard work	
D. Teasing/ complimenting	Participant joins classmates' conversation, and they ask the participant "What did you do with your hair?"	Hostile: mocking hair, negative comments Neutral: no comment or only acknowledges participant response Non-hostile: compliments, positive comments about hair	

E. Social invitation	Classmates are talking about a party and the participant is invited.	Non-hostile: excited and positive response if the participant can attend, encouraging response if the participant cannot attend	
F. Rule breaking	Participant must ask the classmate to stop vaping in the school toilet.	Hostile: offended, tells participant to mind their own business Non-hostile: NPC reacts positively and listens to the participant's instruction	

Intervention delivery

Design

A case series design was used in this study to primarily examine the feasibility and acceptability of this VR-CBT intervention for autistic adolescents experiencing social anxiety.

Participants

The study aimed to recruit five participants to complete the intervention. This sample size was chosen as it provides sufficient information on feasibility and acceptability for a case series design, as recommended by the Medical Research Council (2019). However, this sample size was not determined based on statistical parameter estimates.

To be eligible for the study participants had to meet the following inclusion criteria:

- Be aged between 13 to 18 years.
- Be diagnosed with ASD (confirmed by a neurodevelopmental clinician (e.g., psychologist, psychiatrist) or team or clinical reports.
- Have a clinical diagnosis of social anxiety or be experiencing anxiety in social situations (i.e. typical and/or atypical social anxiety) that is impairing daily functioning as determined by their referring clinical team.

- Can sufficiently speak and understand English fluently to access the intervention.
- Be suitable for the intervention as deemed by the referring clinical team and researchers based on factors such as desire to participate, motivation, and willingness to undertake exposure-based tasks.

Participants were excluded from the study if they met the following:

- Have a diagnosis of photosensitive epilepsy.
- Were receiving concurrent psychological therapy as this can interfere with this intervention.
- Have immediate/upcoming plans for their psychopharmacological medication regimen to change as this can interfere with this intervention.
- Have a diagnosis of a learning disability.
- Have current/active risk (e.g., self-harm, suicide, harm to or from others).

Participants were recruited from national specialist or local CAMHS services from SLaM. Participants had completed assessments with these services and were on the wait list (WL) for psychological interventions. Those who participated in the study remained on these WL and were able to access these after completing the study if they wished to have further psychological support.

The study was presented to services during team meetings or teams were emailed the study details, participant and parent information sheets (Appendix 4) and eligibility criteria. Eligible participants were approached by clinicians (such as psychologists, and care co-ordinators) at these services to gauge participant interest in the study. Participants and/or their parents/guardians who were interested in the study consented to share their details. The researchers then checked for eligibility against the inclusion/exclusion criteria by consulting with the referring clinician and through screening on the SLaM's Electronic Patient Journey System (ePJS). Participants who met eligibility were emailed the information sheet and offered an initial face-to-face consultation lasting around 30-45 minutes. During this consultation, participants and their parents/guardians were given an overview of the study, information on the intervention and rationale before completing the consent and/or assent forms (Appendix 5).

VR-CBT intervention procedure

The intervention was delivered to all participants by one therapist TU (trainee clinical psychologist) who had one-hour biweekly supervision with MH (qualified clinical psychologist) who specialised in CBT for autistic children and young people. The same therapy protocol and resources were used for all participants; however, VR scenarios were selected based on client presentation and preference. All participants were seen at The Michael Rutter Centre, SLaM. Participants were offered twelve weekly face-to-face sessions, each lasting 75 minutes. The first 60 minutes of each session involved the therapist and the participant. The participant's parent/guardian joined for the final 15 minutes to support in reviewing the content and engaging with the homework tasks set.

A therapy protocol was created with reference to a previous VR-CBT protocol by Valmaggia and colleagues to form the framework for using VR as well as Leigh & Clark's *'Cognitive Therapy for Social Anxiety Disorder in Adolescents'* manual. As there was no existing CBT manual for social anxiety for autistic adolescents specifically, adaptations to this manual were made to support engagement and socialisation to the CBT model. Examples of the adaptations included additional time for rapport building, emotion literacy, ASD psychoeducation, use of special interests and communication aids. The intervention was designed so that VR complemented CBT for social anxiety and did not act as a stand-alone intervention.

The 12-week VR-CBT program began with building a strong therapeutic alliance and psychoeducation on social anxiety in the context of ASD before familiarising participants with the VR technology. Sessions then focused on supporting participants to recognise, understand, and regulate emotions. Midway, the program shifted to identifying safety behaviours and practising dropping these using the VR. Participants then developed an exposure hierarchy in which they were immersed into using the VR, while also using VR to practice social skills. Later sessions included attention training, which was consolidated through VR practice and optional problem-solving or cognitive restructuring. The final session involved the development of a blueprint for relapse prevention. Participants had access to all VR scenarios but could select and practice those that were most relevant to their presenting concerns. A detailed session-by-session summary of the therapy protocol is shown in Appendix 6.

Measures

All measures were completed on paper before being scanned and uploaded to a secure OneDrive folder. The data from the measures were also entered into a Microsoft Excel spreadsheet which was saved in the same folder. This data was kept anonymous (participants were given unidentifiable ID numbers) and the OneDrive folder was only accessible to the research team.

Measures for Sample Characterisation

These measures were taken pre-intervention only. First, demographic data was collected including age, gender, ethnicity, any other mental health diagnoses, any current medication, current school type and level of education, history of psychological therapies received and household income. Next, measures were administered to provide an understanding of each participant's ASD profile and therefore any additional considerations or adaptations that should be made when administering the intervention.

The *Social Communication Questionnaire* (SCQ; Rutter et al., 2003; Appendix 7) is a 40-item questionnaire which is completed by parents/guardians of autistic children and young people aged 4 years and over. The SCQ screens for current social communication features related to ASD. The parent/guardian answers "yes" or "no" to each item relating to the participant in the last three months. Higher scores indicate greater social communication impairment. Studies investigating diagnostic validity have suggested that scores of 15 and higher are indicative of ASD (Berument et al., 1999). The SCQ is a validated screening tool which is appropriate to use when screening adolescents (Hirota et al., 2018).

The *Toronto Alexithymia Scale* (TAS-20; Bagby et al., 2006; Appendix 8) is a self-report measure of alexithymia. It is a 20-item questionnaire relating to how individuals understand and express their feelings. Participants rate each statement on a 3-point Likert scale (0 = "not true", 1 = "sometimes true", 2 = "often true"). Indicated items are reverse scored before calculating a total score. Higher scores are indicative of alexithymia. The TAS-20 is an established and popular measure for assessing alexithymia (Lumley, 2000), has good psychometric properties (Bagby et al., 1994) and has been validated for use in clinical populations (Parker, Taylor & Bagby, 2003)

Feasibility and acceptability measures

Feasibility of the intervention was considered using:

1. Participant recruitment rate, which is the number of participants who were approached for the intervention and agreed to take part.
2. Retention rate, which is the number of participants who commenced the intervention and completed it. Completion is defined as 9 out-of-12 (75%) VR-CBT sessions attended.
3. Adherence to the intervention such as the number of sessions attended, and the number of homework tasks (e.g., exposure tasks, diaries) completed.

Acceptability of the intervention involved gaining qualitative feedback from participants using a semi-structured interview conducted post-intervention. Interviews were conducted online using Microsoft Teams, which was also recorded. The interview questions (Appendix 9) were created by the researchers and aimed to elicit information about the experience of the intervention and VR specifically. Questions included views on what was helpful and unhelpful about the therapy, how applicable the VR was to reality, how immersive the VR was, if the scenarios were relatable and anxiety-provoking, and any suggestions for improvement.

To supplement the semi-structured interviews, the Information and Communications Technology Sense of Presence Inventory short version (ITC-SOPI; Lessiter et al., 2001; Appendix 10) was administered to participants post-intervention. The ITC-SOPI is a 12-item self-report questionnaire that measures experiences of media including sense of presence, engagement, negative effects, and ecological validity. For each item, participants rate how far they agree or disagree on a 5-point Likert scale (1 = strongly disagree; 2 = agree; 3 = neither agree nor disagree; 4 = agree; 5 = strongly agree). For this study, a total score was not calculated, instead, responses were referred to during the interview to elicit more information regarding the experience of VR.

Clinical Outcome Measures

The following measures were selected as they address the aims of the intervention, are appropriate to use with autistic youth, show high levels of validity and reliability within literature, and provide an appropriate level of data for a feasibly study. Each measure was administered pre-intervention, post-intervention (immediately after the final session) and at 6-week follow-up.

The *Revised Children's Anxiety and Depression Scale (RCADS* Appendix 11*)* and *The Revised Child Anxiety and Depression Scale – Parent Version (RCADS-P;* Appendix 12; Chorpita et al., 2000) is a 47-item questionnaire that is completed by the participant and their parent/guardian respectively. It is suitable to examine depression and anxiety symptoms in young people aged 8-18 years. The RCADS and RCADS-P both have subscales to screen for different disorders including generalized anxiety disorder, separation anxiety, OCD, social phobia, total anxiety, panic disorder, and major depressive disorder. The total anxiety subscale and the social phobia subscale were used for this study. For each item, respondents select how often each symptom occurs on a 4-point Likert scale (0 = "Never"; 1 = "Sometimes", 2 = "Often", 3 = "Always"). Higher scores are indicative of increased anxiety and/or depression symptoms. The RCADS is a validated measure that is coherent with criteria for anxiety and depression on the DSM (Chorpita et al., 2000) and has been shown to be valid for use with autistic youth (Sterling et al., 2015).

The *Goal Attainment Scaling* (GAS; Appendix 13) is a structured measure which examines the extent to which an individual's goals are achieved following an intervention (Kiresuk & Sherman, 1968; Turner-Strokes, 2009). GAS uses "a priori" criteria where a "successful" outcome is agreed on by the participant and clinician before the intervention commences. Goals are then revisited after the intervention is completed to determine how well this was achieved. At pre-intervention, two to three SMART (Specific, Measurable, Achievable, Relevant, Time-bond) goals are set. Participants then rate the importance (0-4, with 4 being most important), difficulty (0-4, with 4 being most difficult) and how they are functioning at baseline (-2 = none or -1= some function) for each goal. Post-intervention, participants indicate how well the goal was achieved (+2 = better than expected, +1 = fully achieved, 0 = partially achieved, -1 = same as baseline, -2 = worse than expected). The GAS has shown promise for use with autistic populations (Ruble et al., 2012) and has been widely used to evaluate mental health interventions (Lee et al., 2021).

Scoring and Analysis

As this study utilised a feasibility and acceptability case series design, analyses were exploratory. Formal sample size calculations and inferential statistics were not undertaken. Guidance for reporting on case series was followed (Abu-Zidan et al., 2012).

Descriptive statistics for feasibility including recruitment rate, retention rate, attendance and homework adherence were calculated. In assessing the acceptability of the intervention, the semi-structured interviews were analysed using a thematic analysis (Braun & Clarke, 2006). As this was an exploratory study in which a novel intervention was used, we used a data-driven or inductive approach. This allowed for knowledge to emerge from the data itself and limits bias from pre-determined codes as highlighted in previous feasibility studies (Horwood et al., 2021). The interviews were first transcribed using Microsoft Teams. Data was then familiarised before creating initial codes from emerging topics. The codes were then grouped into themes which were then reviewed, organised, and defined. Finally, the researchers met to discuss the emerging themes and finalise them. Quotes were extracted to illustrate these themes.

For the clinical outcome measures, we aimed to determine whether VR-CBT can improve anxiety using a reliable change index (RCI; Jacobson & Truax, 1991). Reliable change or improvement in this context does not provide evidence of efficacy or effectiveness but instead examines observable reductions in anxiety symptoms for individual participants. In calculating for reliable change, a t-score for the RCADS and RCADS-P total anxiety and the social phobia subscales was calculated for each participant at pre-intervention, post-intervention and 6-week follow-up. This was completed using the RCADS/RCADS-P scoring programme v3.3, created by the developers, which allows raw scores to be converted into t-scores. The t-scores were used in calculating the RCI (Jacobson & Truax, 1991). The RCI is a calculation that determines any reliable improvement or deterioration for each participant between two time points. The calculation uses a normative sample value of test re-test reliability and a variance (standard deviation) from this sample which was extracted from previous literature (Ebesutani et al., 2015; Kösters et al., 2015). The difference between the participant’s scores at timepoint 1 and timepoint 2 is divided by the standard error of this difference (Evans et al., 1998). If this is higher than 1.96 times the standard error difference, then there is 95% certainty that there is a statistically reliable change which is not due to chance. The formula (Bauer et al., 2004) is as follows:

$$RCI = \frac{x_{post} - x_{pre}}{\sqrt{2S_E^2}}$$

The standard error (SE) for this formula is calculated by:

SE= SD√1-r

Key

Xpre = timepoint 1 score

Xpost = timepoint 2 score

SD = standard deviation from the normative sample

r = test-retest reliability (coefficient alpha) from the normative sample

To assess goal achievement following the intervention, the GAS calculation sheet was used (https://www.kcl.ac.uk/cicelysaunders/resources/toolkits/gas-overview). GAS t-scores are calculated using the numerical weight of each goal (importance times difficulty), the numerical level of achievement that was rated at pre-intervention, post-intervention and follow-up and the expected correlation of the goal scales (which according to the developers of the tool approximates 0.3; Kirusek & Sherman, 1968). The GAS formula is then used to calculate a baseline score, a post-intervention score and a follow-up score. If the post-intervention or follow-up score is higher than the baseline score, this suggests that the participant has successfully achieved their goals. The formula is as follows:

$$\text{Overall GAS} = 50 + \frac{10\Sigma(W_i X_i)}{\sqrt{((1-\rho)\Sigma W_i^2 + \rho(\Sigma W_i^2))}}$$

Wi = weight assigned to each goal

xi = numerical value for level achieved (between –2 and + 2)

p = the expected correlation of the goal scales (0.3 used as advised by Kirusek & Sherman, 1968).

RESULTS

Feasibility

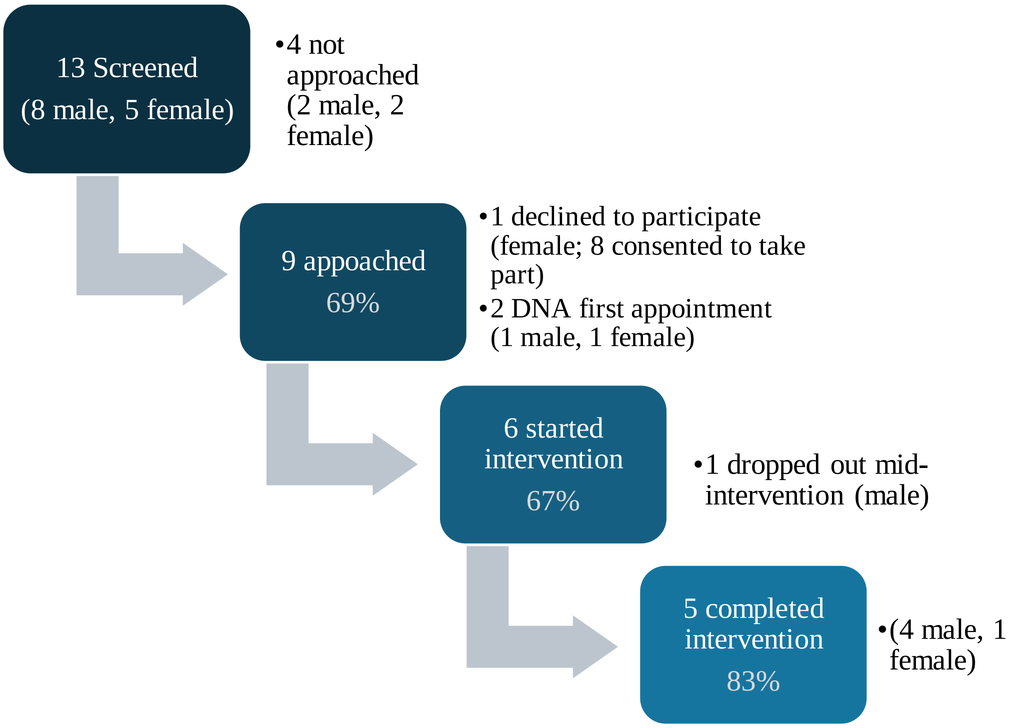
Recruitment and retention

The recruitment process and retention rates are shown in Figure 1. A total of 13 participants (62% males, 38% female) were referred for the intervention and screened against the study eligibility criteria. Four participants were not approached as they did not meet criteria (reasons including having co-occurring psychological interventions, active risk, or diagnosis of a learning disability). Overall, the recruitment rate (referrals that were screened, deemed eligible for the study, and therefore contacted to take part) was 69%.

Of the nine participants (67% male, 33% female) that were approached, one declined to participate due to accepting another intervention at their CAMHs service. Two more participants, who consented to take part, did not attend their first session and despite offers of further appointments and attempts to support with engagement, they did not begin the study. Therefore, six of the nine participants (67%) who were approached to take part started the intervention.

Of the six participants who started the intervention (67% male, 33% female), one dropped out after attending only three sessions due to increased risk and difficulty engaging with the school environment because of their history of school bullying. Therefore, five of these six participants (83%) were retained during the intervention. As per our research aims, these five participants (80% male, 20% female) completed the intervention (completion was defined as attending nine-out-of-twelve sessions; 75%).

Figure 3. Recruitment and retention process and rates



Participant characteristics

Demographic information for the participants who completed the study is shown in Table 3. The participant who dropped out of the study and was not included in our analysis was a

Mixed White and Black female aged 16 years. There was a range of participant ages across the adolescent span (13-18 years). Almost all participants were male with only one female (20%) participant completing the intervention. The participants were also majority White-British with only one participant (20%) coming from a minoritised ethnic group.

Table 3. Participant demographic data

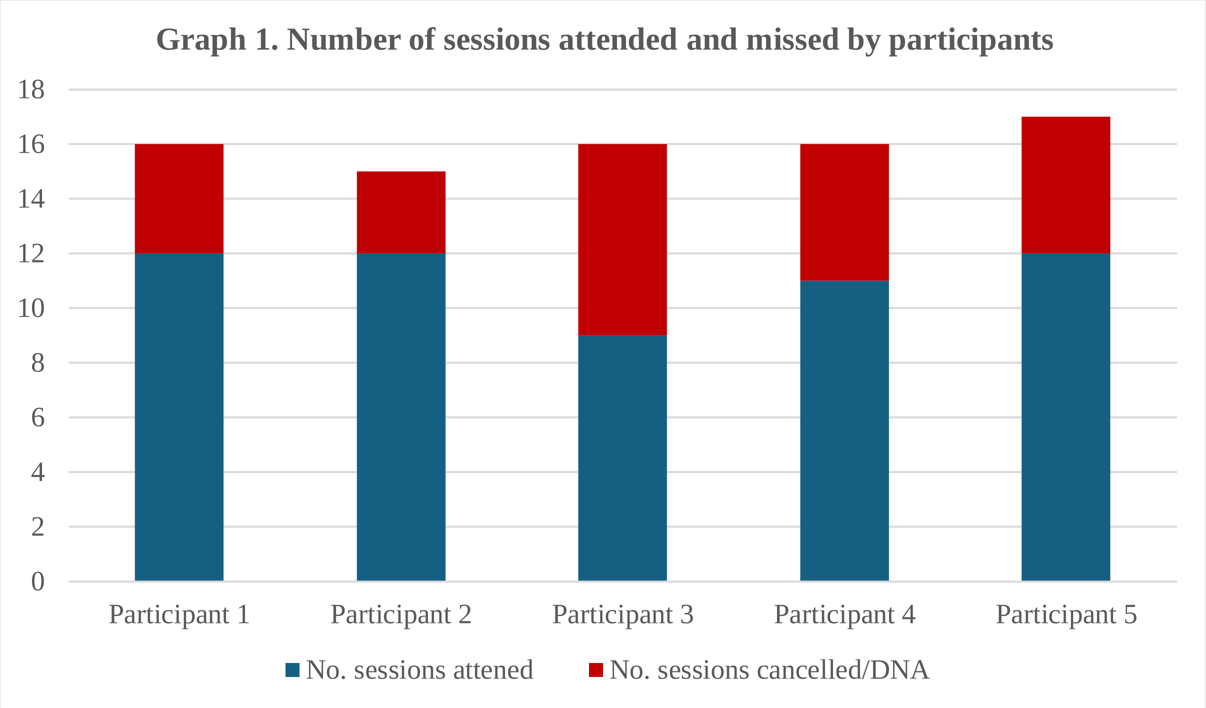
Demographic	**n (%)**
Age	
13-14	2 (40%)
15-16	2 (40%)
17-18	1 (20%)
Gender	
Male	4 (80%)
Female	1 (20%)
Ethnicity	
White-British	4 (80%)
Black British	1 (20%)

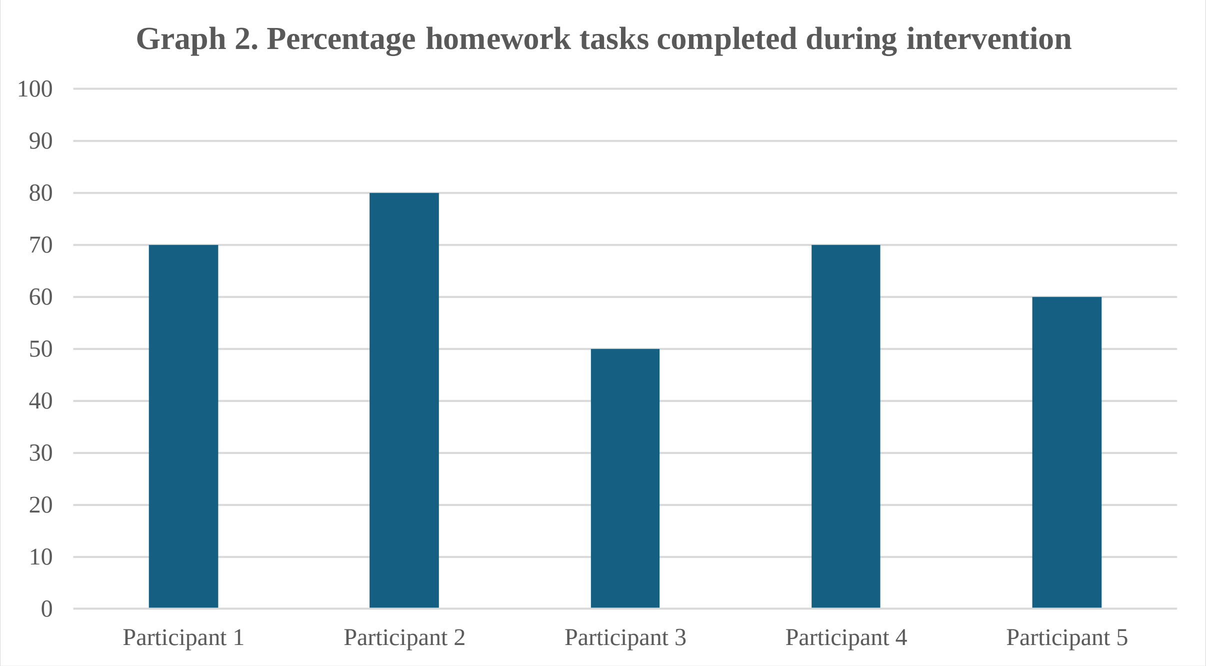
Adherence to the Intervention

Data has been reported for the five participants who commenced and completed the intervention. Three participants attended all 12 sessions, one participant attended 11 and one participant attended 9 sessions. Therefore, an average of 11 sessions were attended. As shown in Graph 1, participants often missed appointments (i.e., cancelled or did not attend). Reasons for missing appointments included difficulties with transitioning into therapy, difficulties with anxiety symptoms, sessions clashing with other commitments or sickness. Due to this, an average of 16 appointments needed to be offered to participants before they were able to reach the completion target.

The intervention also involved ten homework tasks for participants to complete. Whether each participant completed each homework task was determined by the therapist (TU). The rate of homework completion is shown in Graph 2. The average number of completed homework tasks for the intervention was six (60% homework completion rate).

For the five participants, 100% of participant measures were completed pre-, post-intervention and at follow-up. Likewise, 100% of parent measures were completed pre-, post-intervention and at follow-up.





Acceptability

All five participants who completed the VR-CBT were interviewed post-intervention. Four themes were identified from the interviews: engagement with VR; appropriateness for autistic adolescents; using VR to socialise to the CBT model and improving the intervention. A summary of these themes is provided.

Theme 1: Engagement with VR

An emergent theme reported by all participants was engagement with the VR. In terms of getting used to the VR, the feedback was variable. Three participants reported that they were quickly able to engage with VR, reporting no cybersickness. Of these, two also reported that it was helpful to become accustomed to the VR first (through practising wearing the headset or walking around the VR waiting room). However, the other two participants noted that initially the VR induced cybersickness (dizziness and nausea from using the headset) during the initial practice which had passed over time with continued use.

Participant 5: *"It made my head spin at first but that got better when we practised it [VR] and when you do the tasks [scenarios] you forget that anyway."*

Like many young autistic people, four participants expressed their interest in technology and gaming meaning they had good buy-in with the intervention straight away. They therefore felt ready to engage.

Participant 1: *"I was excited because I have my own one [VR] at home, and I do lots of online gaming at home."*

Participant 2: *"I've always wanted to try it, so I found it fun to try… it was scary to start but I got used to it."*

Four participants also reported the usefulness of the school-based environment and its relevance for young autistic adolescents. They reported that it triggered anxiety to what they had previously experienced and, hence, it applied to their real world. Likewise, the participants valued the range of scenarios used as well as being able to practice with different levels of hostility, noise, and crowdedness as it allowed them to practice skills in a range of formats like that experienced in the real world.

Participant 1: *"I liked practising the different scenarios as I could use what we learned in different ways which made me better at this when I practised outside."*

Participant 3: *"It was nice to do the nice [non-hostile] ones first and then the other [hostile] ones. I felt more comfortable when we kept doing them."*

The VR was also reported to be realistic and engaging by all participants. Two participants reported that they were drawn into the scenario as if they were really there. All participants reported that they felt it was immersive and therefore engaging. Helpful components reported by participants included being able to walk and move around the environment, NPC reactions and the realism of the school environment. Participants reported that this allowed them to experience the physiological and emotional arousal of real situations.

Participant 5: *"I know it's a cartoon like video games, but I did get into it… I spoke to people without having to speak to people in real-life which I don't think I could do without practice."*

Participant 2: *"The characters [NPCs] felt pretty real, so I did feel a bit anxious speaking to them… my heart was beating more, and I was breathing more."*

There were also indirect advantages to the VR component such as motivating participants to attend face-to-face sessions and providing a dynamic and interactive way to practice CBT skills.

Participant 4: *"I was really worried about therapy, but this let me do something different and not just talk all day which I don't like."*

Participant 2: *"I liked being able to practice more between the therapy stuff… it was my favourite part of going to therapy."*

Theme 2: Appropriateness for autistic adolescents

Participants noted how the intervention was supportive of the needs of autistic individuals. Three participants noted that the process of using VR was structured and provided a routine for therapy. One of these participants highlighted how this was lacking when they previously engaged with talking therapies. These participants highlighted that the structure of first engaging with CBT materials and discussing with the therapist before commencing VR was a helpful process.

Participant 1: *"I like learning the skills and then practising them. Last time I did therapy we had to talk too much, I don't like that."*

Four participants expressed the value of doing over talking with VR. This is important considering autism profiles where it can be difficult to identify and express thoughts and feelings without practical support. Participants noted the in vivo element of the VR allowed them to share thoughts and feelings in real-time which felt less pressuring compared to asking them to recall and share their experiences without such prompting.

Participant 2: *"I found it easier to talk about what I was thinking and feeling when we were doing it [VR], I didn't have to try too hard, and you [therapist] would help me to share when we were doing it [VR]."*

Similarly, three participants noted that VR helped them discover new thoughts and feelings. The in vivo element meant that participants could experience and identify sensations which might be less observable or difficult to identify otherwise. Participants also stated that they could identify these sensations in themselves and others (i.e. the NPCs) which was important considering the dynamic nature of social anxiety.

Participant 2: *"I could come up with feelings that I didn't really think of before. Like when you're actually doing it, I could see that 'Oh I feel shaky this is because I'm worried what they're [NPCs] thinking."*

Participant 3: "Cause I'm doing it really, I found it a bit easier to know what I'm feeling and what the others [NPCs] are feeling too and talk about it."

Theme 3: Using VR to socialise to the CBT model

The participants saw value in how VR can enhance learning from CBT. Two participants noted this during the formulation stage and in developing a shared understanding with the therapist. As highlighted in Theme 2, the interactive and in vivo nature of VR allowed participants to readily make connections between thoughts, feelings, and actions. In doing so, they could also share more readily with the therapist to create an idiosyncratic understanding of how difficulties present.

Participant 5: *"We used the virtual reality to practice what we learned. I would speak to the character [NPC] and think about what I was thinking and feeling straight away and after, talk about how they all link together."*

This also meant that the intervention was individualised, and formulation driven. Three participants valued that the VR scenarios were selected based on their presenting difficulties and their preferences. This means the VR exposure was more relatable to participants to maximise impact.

Participant 2: *"We kept practising speaking to the headteacher and the boy that was smoking because I was worried about arguing with others."*

Participant 4: *"I'm scared of crowds, so we'd practice more and more with lots of students, and I got better at it."*

During exposure tasks, participants felt that they could practice social situations without using safety behaviours to increase familiarity with the social anxiety model before this was set as a homework task. Likewise, setting VR scenarios with increasing difficulty was seen as useful for completing the exposure hierarchy. Three participants said this built their confidence when carrying out tasks in the real world.

Participant 2: *"I liked practising speaking with others without the safety behaviours before doing it properly in real-life. Like I practised not stopping eye contact or rehearsing what I say in our session first, so I felt like more ready."*

Two participants noted that VR was also useful in coaching CBT skills such as attention training.

Participant 5: *"We learned not to focus on me and then I practised it by focusing on the NPCs or maybe the environment instead which helped."*

Theme 4: Improving the intervention

While participants generally had positive experiences with VR, all highlighted areas for improvement to enhance immersion, relatability to social anxiety and the quality of the intervention.

With two participants reporting initial feelings of cybersickness when using the VR, they highlighted a need for extended practice. One participant suggested having an additional session before therapy began to enable this practice.

Participant 5: *"I did feel dizzy at the start so just more time to get used to it [VR] in the wait room."*

Participant 1: *"One more session to practice it [VR] would have helped it was a lot to practice and do the therapy all at once."*

One area of improvement highlighted by three participants was to ensure that NPC interactions ran more smoothly. For example, during some scenarios, there would be a delay between the participant approaching the NPCs and the NPCs speaking that could interrupt the flow of a social interaction. Likewise, while most participants highlighted how realistic conversations with NPCs were, two participants stated that there was a limited range of responses which meant that repeated practice soon became predictable. They therefore suggested the need for a greater range of NPC responses and flow in their conversations.

Participant 1: *"I already knew what they would say by the end [of treatment] so it wasn't as difficult."*

Similarly, three participants suggested using a greater variety of environments in the future, including ones that had previously provoked social anxiety for them. This included public transport, shopping centres, parks, and public speaking.

Participant 3: *"I think having different places would be better. I found the school ok but something like being in public or shopping I feel may have been better."*

Participant 2: *"The school was good for me because I wanted to go back to school but I would have liked to practice other places just like we did for homework so I can practice first."*

Two participants also suggested having longer scenarios with one participant also suggesting that these scenarios could get longer as they grew more confident. This will allow for gradual exposure of increasingly difficult social interactions.

Participant 4: *"They were a bit short. I could have longer VR practices to practice even more when I got used to being with it."*

Three participants also highlighted that they would have benefitted from more than 12 sessions, highlighting that the intervention was too short. They reported that a greater number of sessions would be useful to allow for further VR practice and time to review tasks on the exposure hierarchy. They also suggested that a greater number of sessions would be useful to spend more time on other CBT tasks such as emotion recognition and regulation and attention training.

Participant 4: *"More sessions would have let me practice the tasks more so that I'm confident before finishing therapy."*

Participant 1: *"I would like more time to spend on the different tasks like changing attention and changing my thoughts which I find hard…We quickly moved on to the next thing, so it was a bit rushed."*

Clinical outcome measures

Anxiety – Reliable Change Index

Table 4 shows the test re-test reliability data and standard deviations extracted from previous research (Ebesutani et al., 2015; Kösters et al., 2015). These were used to calculate the RCI (the minimum difference in scores required for a reliable change) for the RCADS and RCADS-P total anxiety and social phobia subscales.

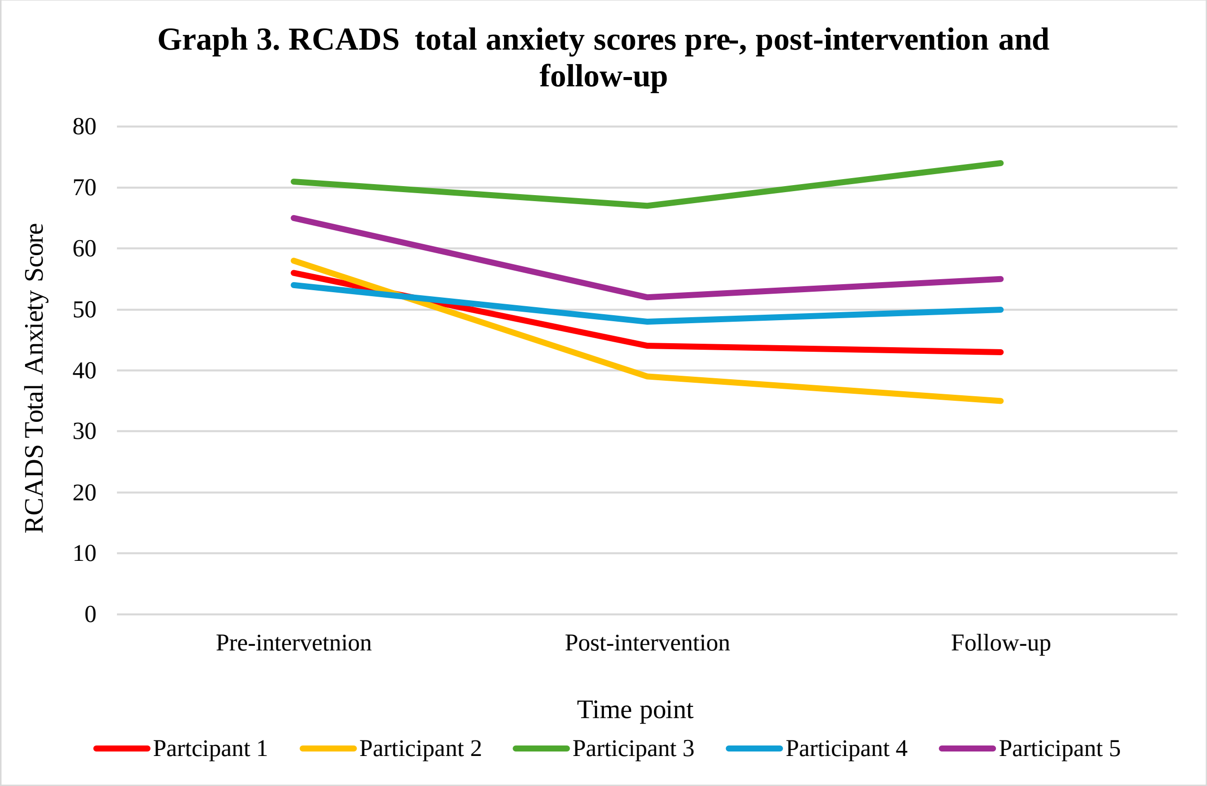
Table 4. Reliability data from previous research, and Reliable Change Index (RCI) calculations for RCADS and RCADS-P total anxiety and social phobia scales

	Test re-test reliability (Cronbach's Alpha)	Standard Deviation (SD)	Reliable Change Index (RCI)
RCADS Total Anxiety	0.94	16.9	11.47
RCADS-P Total Anxiety	0.94	12.95	8.89
RCADS Social Phobia	0.86	5.2	5.39
RCADS-P Social Phobia	0.89	4.99	4.59

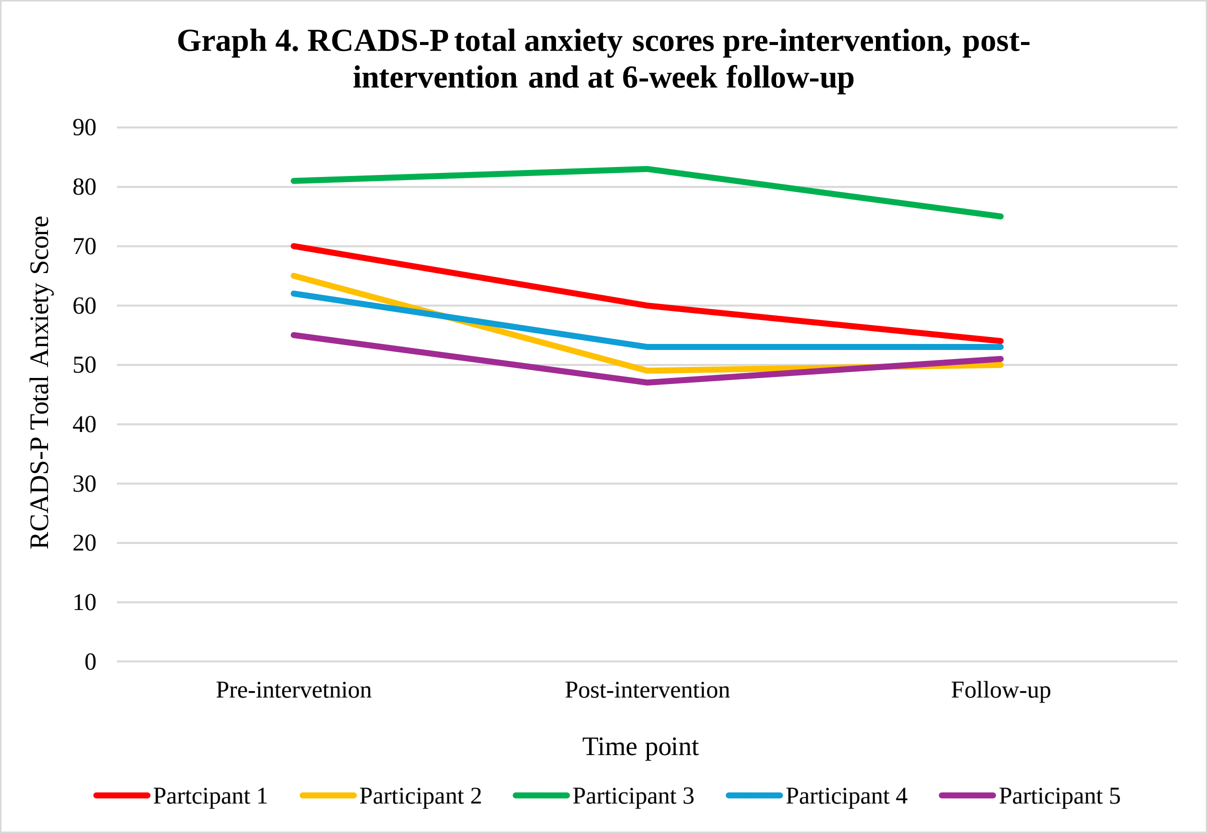
Total anxiety scores on the RCADS and RCADS-P at pre-intervention, post-intervention and follow-up for each participant are shown in Table 5. Graph 3 and Graph 4 also show the change in scores at the three time points. The difference in scores and whether these were indicative of reliable change is shown is Table 6.

Table 5. Individual scores for RCADS and RCADS-P total anxiety at pre-intervention, post-intervention and at follow-up

	RCADS Total Anxiety			RCADS-P Total Anxiety		
	Pre-intervention	Post-intervention	Follow-up	Pre-intervention	Post-intervention	Follow-up
Participant 1	56	44	43	70	60	54
Participant 2	58	39	35	65	49	50
Participant 3	71	67	74	81	83	75
Participant 4	54	48	50	62	53	53
Participant 5	65	52	55	55	47	51



Graph 3. RCADS total anxiety scores pre-, post-intervention and follow-up



Graph 4. RCADS-P total anxiety scores pre-intervention, post-intervention and at 6-week follow-up

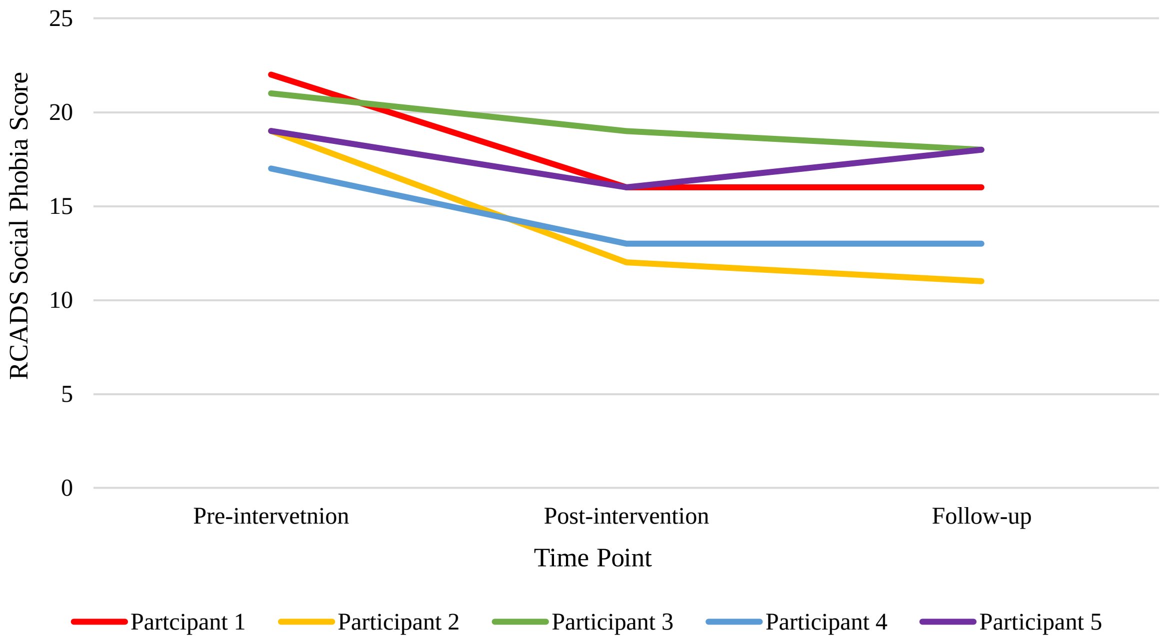
Table 6. Differences in total anxiety scores and if RCI criterion was met from pre-intervention to post-intervention and pre-intervention to follow-up

	Change in RCADS Total Anxiety Score				Change in RCADS-P Total Anxiety Score			
	Pre to post-intervention	Reliable change?	Pre-intervention to follow-up	Reliable change?	Pre- to post-intervention	Reliable change?	Pre-intervention to follow-up	Reliable change?
Participant 1	-12	*	-13	*	-10	*	-16	*
Participant 2	-19	*	-23	*	-16	*	-15	*
Participant 3	-4		3		2		-6	
Participant 4	-6		-4		-9		-9	
Participant 5	-13	*	-10		-8		-4	
Total Reliable change found		3		2		2		2
Reliable change: "*" indicates reliable change present								

Social phobia scores on the RCADS and RCADS-P at pre-intervention, post-intervention and follow-up for each participant are shown in Table 7. Graph 5 and Graph 6 also show the change in scores at the three time points. The difference in scores and whether these were indicative of a reliable change is shown in Table 8.

Table 7. Individual scores for RCADS and RCADS-P social phobia at pre-intervention, post-intervention and at follow-up

	RCADS Total Anxiety			RCADS-P Total Anxiety		
	Pre-intervention	Post-intervention	Follow-up	Pre-intervention	Post-intervention	Follow-up
Participant 1	22	16	16	24	18	17
Participant 2	19	12	11	18	11	12
Participant 3	21	19	18	23	23	21
Participant 4	17	13	13	17	16	14
Participant 5	19	16	18	18	13	14


Graph 5. RCADS social phobia scores pre-, post-intervention and follow-up

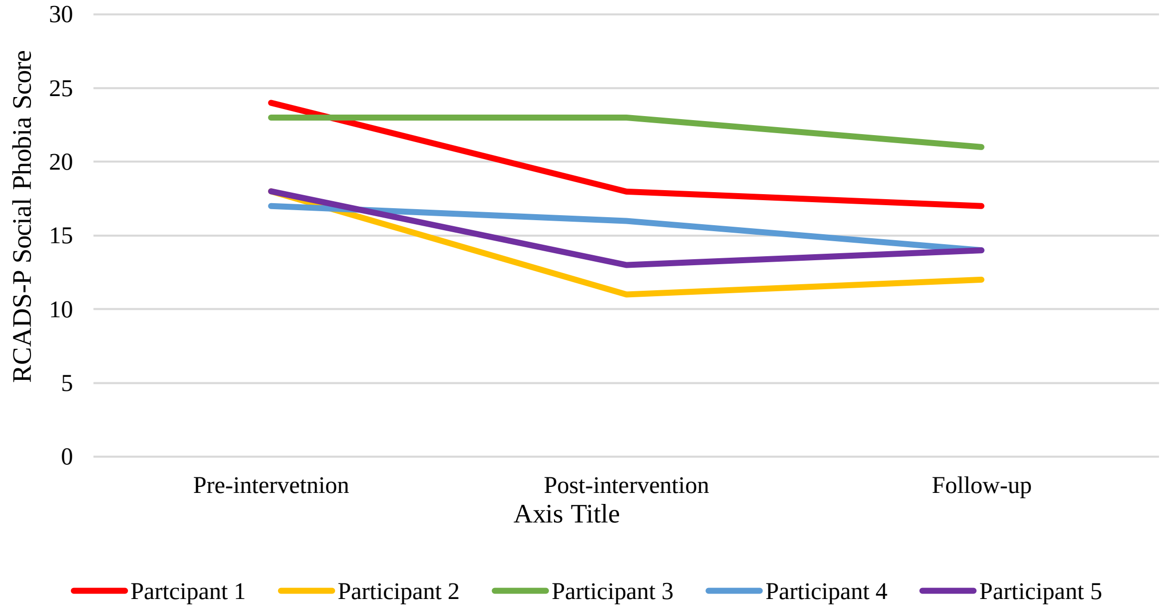

Graph 6. RCADS-P social phobia scores pre-, post-intervention and follow-up

Table 8. Differences in social phobia scores and if RCI criterion was met from pre-intervention to post-intervention and pre-intervention to follow-up

	Change in RCADS Social Phobia Score				Change in RCADS-P Social Phobia Score			
	Pre- to post-intervention	Reliable change?	Pre-intervention to follow-up	Reliable change?	Pre- to post-intervention	Reliable change?	Pre-intervention to follow-up	Reliable change?
Participant 1	-6	*	-6	*	-6	*	-7	*
Participant 2	-7	*	-8	*	-7	*	-6	*
Participant 3	-2		-3		0		-2	
Participant 4	-4		-4		-1		-3	
Participant 5	-3		-1		-5	*	-4	
Total Reliable change found		2		2		3		2
Reliable change: "*" indicates reliable change present								

At pre-intervention, all five participants' scores on the RCADS and RCADS-P total anxiety and social phobia subscales were above the clinical cut-off. For total anxiety, four participants showed a reduction in scores for both the RCADS and RCADS-P from pre- to post-intervention. These participants also showed a decrease in total anxiety scores for both measures from pre-intervention to follow-up. However, between post-intervention and follow-up, there was a marginal increase in RCADS and RCADS-P total anxiety scores for participant 5 and a marginal increase in RCADS total anxiety scores for participant 4 (though scores did not return to baseline). Participant 3 showed fluctuations in scores for both the RCADS and RCADS-P at post-intervention and follow-up, which is explored in the case reports below.

As shown in Table 6, two participants out of five (40%) showed a reliable change in both measures for total anxiety across all time points. Additionally, participant 5 showed a reliable change in the RCADS total anxiety only between pre- to post-intervention.

For the social phobia subscale, all participants showed a reduction in scores for both RCADS and RCADS-P from pre- to post-intervention (excluding participant 3 who showed no change on RCADS-P social phobia). All participants also showed a reduction in social phobia scores on both measures from pre-intervention to follow-up. However, between post-intervention and follow-up there was a marginal increase in RCADS and RCADS-P social phobia scores for participant 5 and a marginal increase in RCADS social phobia scores for participant 2 (though scores did not return to baseline).

As shown in Table 8, two participants out of five (40%) showed a reliable change in both measures for social phobia across all time points. Additionally, participant 5 showed a reliable change in RCADS-P social phobia only between pre- to post-intervention.

It is important to note that while a reliable change in scores indicates improvement in anxiety and social anxiety, this is not necessarily indicative of significant clinical improvement and some participants still scored above the clinical cut-off.

Goal attainment scaling

Table 9 shows the scores for goal attainment at pre-intervention, post-intervention, and follow-up as well as a change in scores. Positive change scores indicate goal attainment and the higher this change score, the greater the level of goal attainment. Three participants out of five (60%) showed goal attainment at both post-intervention and follow-up. Two of these participants (40%) also showed further progress in their level of goal attainment at follow-up.

Table 9. Goal attainment scores including change from pre-intervention to post-intervention and pre-intervention to follow-up

	Pre-intervention level	Post-intervention Achievement	Change (pre-to post-intervention)	Follow-up Achievement	Change (pre-intervention to follow-up)
Participant 1	25.9	33.9	8	33.9	8
Participant 2	31.2	41.9	10.8	44.6	13.5
Participant 3	25.9	25.9	0	25.9	0
Participant 4	31.2	36.5	5.4	36.5	10.8
Participant 5	33	33	0	33	0

Case series

A case series for each of the five participants who completed the study is provided. This details background, therapy goals, how the intervention was applied, outcomes, and direct feedback from the participant. Participants’ age, gender (including pronouns) and any other identifiable information has been removed to maintain confidentiality.

Participant 1

Background

Participant 1 was referred to the study by a care co-ordinator following difficulties with generalised anxiety and social anxiety. They previously had some psychology input including parent psychoeducation and CBT for generalised anxiety. However, this ended early as they had moved to a new location. In terms of functioning, they were attending a SEN school two days per week, were spending less time out of their house due to their increasing difficulties with anxiety and were also starting to withdraw from their hobbies.

Participant 1 had two goals:

1. To increase school attendance
2. To be able to go out more to public places independently

Intervention

Participant 1 engaged well with the therapy, having attended all twelve sessions to reach 100% completion. They also completed 70% of the homework tasks set. Participant 1's main presenting difficulties included speaking with new people and larger crowds which formed the foundation of the intervention. Based on this, the participant's exposure hierarchy was based on increasing conversations with new people. The VR scenarios used to support this included *social invitations, asking a question, teasing/complimenting,* and *impromptu speech*. Participant 1 also experienced low self-esteem and negative thoughts about themselves so the flexible session 11 was used for further cognitive restructuring.

Outcome measures and feedback

Participant 1 scored 31 on the SCQ at pre-intervention indicating social communication difficulties. They also scored 59 on the TAS-20 which is indicative of possible alexithymia. They showed good progress with a reliable change in both anxiety and social phobia for the RCADS and RCADS-P at post-intervention. This reduction in anxiety and social phobia symptoms was sustained at follow-up. While Participant 1's first goal to increase school attendance remained unchanged following the intervention, they achieved their second goal by going out more in public (e.g. shopping, going on the bus alone) 2-3 times per week.

Participant 1 had mainly positive feedback about the intervention and stated that they would recommend it to other autistic adolescents with social anxiety. They initially experienced some discomfort and dizziness with the equipment which went away after repeated practice. The participant reported finding the intervention useful in building confidence in social situations such as going out in public and speaking with peers more. They noted finding components of the intervention helpful such as developing a shared formulation, exposure tasks, including testing safety behaviours, and attention training. Their main feedback in improving the intervention included increasing the number of sessions offered, providing more opportunities to practice the VR before starting with the scenarios and offering a greater range of scenarios and NPC responses to further test their anxiety.

Participant 2

Background

Participant 2 was referred to the study by their care coordinator and presented with social anxiety and low mood. They were on the WL for therapy at their local service before being referred to this study and this was their first time engaging with a psychological intervention. In terms of functioning, participant 2 was attending a specialist school around two days per week, but completely withdrew from social activities and would only spend time with trusted family members. While they were not actively self-harming, they were experiencing passive thoughts to harm themselves.

Participant 2 had three goals

1. To increase school attendance
2. To return to their autism social group
3. To no longer have thoughts of suicide/self-harm

Intervention

Participant 2 engaged well with the intervention, having attended all twelve sessions to reach 100% completion. They also completed 80% of their homework tasks. Participant 2’s main presenting difficulties surrounded judgement from others and confrontation. This stemmed from early experiences of being bullied while at their mainstream school. Based on this, the participant’s exposure hierarchy focused on speaking more and asserting themselves during social situations. The VR scenarios frequently used included *teasing/complimenting, being called* to *the head teacher’s office* and *rule breaking.* Participant 2 also experienced low self-esteem and frequent negative automatic thoughts so the flexible session 11 was used for further cognitive restructuring.

Outcome measures and feedback

Participant 2 scored 26 on the SCQ at pre-intervention indicating social communication difficulties. Participant 2 also scored 66 on the TAS-20 indicating alexithymia. Participant 2 showed good progress with reliable change in both anxiety and social phobia for the RCADS and RCADS-P at post-intervention. This reduction in anxiety and social phobia symptoms was sustained at follow-up. Participant 2 also made good progress towards their goals by increasing school attendance and returning to their social group though infrequently. They were still, however, experiencing low mood and passive thoughts of suicide and self-harm post-treatment. They were referred back to their local service following this intervention for support with depression.

Participant 2 had positive feedback about the intervention and stated that they would recommend it to other autistic adolescents with social anxiety. Participant 2 reported that the intervention increased their confidence when socialising and managing difficult or ambiguous social situations. Participant 2 reported finding the VR immersive and interesting and appreciated practising skills before completing tasks in the real world. They also noted the usefulness of attention training from using VR but expressed the need for more time on this. Other feedback included increasing the range of scenarios beyond the school environment.

Participant 3

Background

Participant 3 was referred to the study by their care co-ordinator and clinical psychologist who had completed their initial assessment. Participant 3 was experiencing high levels of anxiety. They had not previously had any psychological input. In terms of functioning, they were not attending school and were rarely leaving their home, withdrawing from social activity, and their hobbies.

Participant 3 had two goals:

1. To increase time spent on hobbies such as going back to football
2. To be able to cope with anxiety by worrying less about being around others

Intervention

Participant 3 found it difficult to engage with the intervention, however, they managed to reach the minimum target for completion by attending 9 sessions (75% completion). They completed 50% of the homework tasks. Participant 3 main difficulties related to being in crowds, speaking to new people who may not understand them and being judged. Their exposure hierarchy was based on speaking more with others, working gradually from family members to new people. The VR scenarios frequently used included *impromptu speech, asking a question, teasing/complimenting,* and *being called to the head teachers office.* Participant 3 found it challenging to engage with the exposure tasks, so the hierarchy was revised and the flexible session 11 was used for problem-solving. Towards the end of therapy, participant 3 reported feeling increased levels of anxiety and they reported symptoms of health anxiety which was not previously discussed at assessment. They reported finding it difficult to engage with therapy and their attendance became infrequent. Participant 3 still worked hard to attend sessions and engaged where they could.

Outcome measures and feedback

Participant 3 scored 27 on the SCQ at pre-intervention indicating social communication difficulties. Participant 3 also scored 59 on the TAS-20 indicating possible alexithymia. Their RCADS and RCADS-P total anxiety subscale scores fluctuated from pre-intervention, post-intervention to follow-up. A marginal decrease in the RCADS and RCADS-P social phobia scores was seen, though this did not meet the criteria for reliable change. The fluctuation in scores may reflect their ongoing difficulties with health anxiety which they expressed post-treatment. Participant 3 did not show progress towards goal attainment. They continued to show high levels of anxiety which was relayed to their local service for further psychological input following this intervention.

Participant 3 stated that the intervention itself was useful and interesting, and stated that they would recommend it to other autistic adolescents with social anxiety. They highlighted, however, that the intervention is only appropriate for *"people who are ready for therapy"* or may otherwise disengage. They reported that it was useful to practice tasks in vivo to better understand what they and others are feeling, however, these VR scenarios needed to be longer to maximise their benefit.

Participant 4

Background

Participant 4 was referred to the study by their previous therapist following the completion of trauma-focused CBT. Their referrer highlighted that while Participant 4 engaged well with this therapy they still presented with significant difficulties with social anxiety which was impacting their school attendance and performance as well as mood and social withdrawal.

Participant 4 had three goals:

1. To socialise with friends outside of school more often
2. To start attending gaming clubs again
3. To learn more about managing anxiety in social situations

Intervention

Participant 4 engaged well with the intervention, having attended eleven sessions (92% completion). They completed 70% of the homework tasks. Participant 4's main difficulties included public speaking and worrying about being judged by others as boring or uninteresting. Their exposure hierarchy involved working up to delivering a presentation to a crowd. The VR scenarios frequently used included *impromptu speech, asking a question,* and *social invitations.* Participant 4 made good progress with the hierarchy so the flexible session 11 was used to continue progress with this.

Outcome measures and feedback

Participant 4 scored 21 on the SCQ at pre-intervention indicating some social communication difficulties. Participant 2 also scored 46 on the TAS-20 which is just below the threshold for possible alexithymia. Participant 4 had a reduction in RCADS and RCADS-P total anxiety and social phobia scores both at post-intervention and follow-up, however, one met the criteria for reliable change. Participant 4 also made good progress towards one goal which was to learn more about managing social anxiety. Though they did not achieve the other two goals set, steps were being made towards this such as starting online gaming with peers first to work towards joining an in-person gaming club. Participant 4 was referred back to their local service with recommendations for regular reviews or to continue input for social anxiety.

Participant 4 had positive feedback about the intervention and stated that they would recommend it to other autistic adolescents with social anxiety. Participant 4 highlighted the usefulness of VR and how it allowed them to explore CBT concepts without overtalking which can be demanding for autistic people. However, they highlighted that more sessions were required which would have supported them to manage their anxiety even further.

Participant 5

Background

Participant 5 was referred to the study by their care coordinator following difficulties with social anxiety. They had no previous psychology input and a recent diagnosis of ASD in the last 18 months. In terms of functioning, participant 5 was attending school twice a week and had a good range of interests and hobbies. However, they were mainly confined to their home and difficulties with anxiety meant that they found it challenging to pursue their interests further.

Participant 5 had two goals:

1. To increase school attendance
2. To join a dance club

Intervention

Participant 5 engaged well with the therapy, having attended all twelve sessions to reach 100% completion. They also completed 60% of the homework tasks set. Participant 5's main presenting difficulties included others not understanding them leading to feeling as though they offended others and anxiety over being at the centre of attention. Their exposure hierarchy was based on increasing social attention by delivering a presentation. The VR scenarios frequently used to support this included *impromptu speech, social invitation, teasing/complimenting,* and *rule breaking.* The flexible session 11 was used for problem-solving as they found it challenging at times to complete the exposure tasks set as homework.

Outcome measures and feedback

Participant 5 scored 22 on the SCQ at pre-intervention indicating social communication difficulties. Participant 5 also scored 52 on the TAS-20 which was just above the clinical cut-off for possible alexithymia. Participant 5 showed good progress with the intervention, with a reduction in RCADS and RCADS-P total anxiety and social phobia scores at post-intervention and follow-up. However, a reliable change was only seen in the RCADS total anxiety at post-intervention and RCADS-P social phobia at post-intervention. Participant 5 did not make progress towards their goals by the end of the intervention, however, they expressed that they felt they were closer to achieving them and may do so with ongoing management of social anxiety. This was a recommendation made when they were referred back to their local service.

Participant 5 had positive feedback about the intervention and stated that they would recommend it to other autistic adolescents with social anxiety. Participant 5 reported that the intervention increased their confidence of using CBT models by being able to readily extract thoughts, feelings, and behaviours through VR. They highlighted that the intervention was also useful for attention training but expressed the need for additional time to practice this. The VR initially triggered some cybersickness for this participant which they said was bearable and went away with repeated practice.

DISCUSSION

Summary of study aims and main findings

This study primarily aimed to test the feasibility and acceptability of a novel VR-CBT for social anxiety in autistic adolescents. Initially, we developed a VR school environment, and a range of anxiety-provoking scenarios based on key literature and stakeholder involvement. These VR scenarios were incorporated into a twelve-session CBT course to immerse individuals into social situations to practise CBT skills and manage anxiety. A case series including five participants was conducted to assess this VR-CBT intervention. To determine the feasibility of the intervention, we assessed the recruitment rate, retention rates, session attendance and number of homework tasks completed. To determine acceptability, participants were interviewed to gain feedback regarding how appropriate, immersive, and useful the intervention was. As a secondary outcome, we also examined if this intervention can reliably change anxiety symptoms and support participants in achieving their goals for therapy.

Feasibility & acceptability

The findings showed that the recruitment and retention rates were feasible for this intervention. Of those who were referred to the study and approached to take part, 69% commenced the intervention. Of these, 83% completed the intervention with only one participant dropping out of the study. With reference to the literature, it is recommended that at least 80% retention is acceptable for a high-quality intervention (Fewtrell et al., 2008), indicating that our intervention has a strong level of buy-in from participants and can retain most participants. Given that this is a novel intervention with a small sample size, it is difficult to compare these figures with similar case series. However, a randomised controlled feasibility trial exploring VR for specific phobias in autistic young people found that of the

35 participants who were offered to take part only three (9%) declined and all who commenced the intervention completed it (Maskey et al., 2019). The findings from the present study are similar and this suggests that the intervention may be appropriate for a larger pilot study before an RCT for further evaluation.

It is also important to note that our study used an opportunity sampling method, recruiting participants through consulting with clinicians from local services for possible referrals. Opportunity sampling often lends itself to those who are perhaps already appropriate for the study so feasibility rates may differ if we used a randomised method. Further, the sampling pool included a tier 3 CAMHS services and tier 4 national specialist services, the latter of which includes more complex presentations and co-morbidities. Of the four participants who did not complete the study (declined, DNA first appointment or dropped out) three of these were referred from tier 4 services. There is therefore an important question as to how feasible this intervention is for different levels of complexity. Autism itself is a spectrum disorder with low-functioning autism and high-functioning autism representing two distinct points on this spectrum. Lower functioning presentations can include behavioural challenges, reduced interest and capacity for social interactions, difficulties with emotion regulation and, often, co-morbid learning disability (Matson & Nebel-Schwalm, 2007). With higher functioning presentations come developed language skills, milder behavioural challenges, and greater motivation for social interaction (Happé & Frith, 2020). Given that VR-CBT is a sophisticated intervention that requires good literacy skills and motivation, it is important to consider its applicability to the autistic population. It may be that the acceptable feasibility rates found only apply to those with less complex and higher functioning presentations.

Indeed, participants with more complex presentations who commenced the intervention experienced difficulties with engagement. Though Participant 3 completed the intervention, they attended the fewest sessions of all the participants and had the lowest completion rate for the homework tasks. Towards the end of therapy, participant 3 revealed that they were experiencing symptoms of health anxiety which was not previously disclosed. They reported that this was a barrier to engagement, and both they and their parent expressed that management of health anxiety first would have been useful before commencing our study. Another participant who commenced the study dropped out after three sessions, citing that the school environment was triggering for them given their history of school bullying. This participant expressed that even non-hostile school-based scenarios were distressing to deter them from continuing with the study. Individuals who have experienced trauma such as bullying will often avoid reminders of traumatic incidents (Ochi et al., 2020). Likewise, bullying is significantly associated with school refusal in autistic children and adolescents and is thought to mediate the relationship between ASD and social anxiety (Ochi et al., 2020; White et al., 2009). It is therefore important to consider how the VR environment may trigger difficult past experiences. Both cases highlight the need for a comprehensive individual assessment to understand how appropriate the intervention is. Studies examining co-morbidities in ASD advocate treating the most severe or impairing condition first to support a client's wellbeing and ability to engage with treatment (Simonoff et al., 2008). This is not to say that this intervention is not useful, but rather that it should be applied at the appropriate time during a young person's journey with mental health services.

Overall, completers of the intervention showed good attendance with an average of 11 sessions attended. Participants required an average of 16 sessions offered before reaching completion with some of the reasons for missing sessions including difficulties with adjusting to therapy and anxiety surrounding attending therapy. Indeed, these barriers are typically seen in autistic youth: transitions into therapy can be challenging especially as this involves a change in routine and a new environment (National Autism Centre, 2015). Likewise, it can take time for autistic youth to establish a rapport with new therapists due to challenges in communication and being understood by others (Chevallier et al., 2012). Therapy also requires a high level of commitment and can be particularly demanding for autistic individuals who may need more time to learn and practice communication strategies to express their thoughts and feelings (Tager-Flusberg & Kasari, 2013). It will be important to be flexible and allow more time when administering this intervention in future studies; non-attendance may not be an indication of poor engagement but rather due to challenges that arise with ASD.

Adherence should also be considered alongside participant feedback whereby three of the five participants had suggested a need for more sessions. These participants expressed needing more time to get used to therapy and engagement and two participants highlighted needing more time to practice the VR. There are no set recommendations for the number of sessions of CBT that should be offered to autistic adolescents. However, Sharma and colleagues' (2021) systematic review of CBT in autistic children and young people found a modal number of 16 sessions. Storch et al., (2013) suggested that between 16-20 sessions of

CBT is effective in reducing anxiety and should be considered in standard treatment protocols. They also suggested that the number of sessions may vary based on the presentation and needs of each client. Considering the limited time, therapist availability and resources of this study, as well as consultation with evidence-based treatment models for social anxiety, 12 sessions were deemed appropriate. A future pilot study, however, should consider this feedback and there may be scope to increase the number of sessions accordingly.

Interviews with the participants showed the intervention to be acceptable, with all reporting that they would recommend VR-CBT to other autistic adolescents with social anxiety. All participants reported the VR to be immersive and therefore engaging. This meant that they could experience the physiological and emotional arousal of real social situations to readily engage with CBT. Our findings are congruent with previous research. Bekele et al., (2014) found a VR-based anxiety programme had high levels of satisfaction and engagement among autistic children. A VR-based social training intervention was also found to be immersive, enjoyable, and engaging for autistic children (Kandalaft et al., 2013). Our study was one of the first to examine VR-CBT in the context of ASD and social anxiety, and taken in tandem with these previous studies, demonstrates its potential to engage this client population.

Indeed, the benefits of VR in enhancing CBT were highlighted in this study. First, in vivo opportunities for clients and therapists to experience together ‘live’ enables valuable insights into a client’s presenting problems. This allows for a powerful formulation which sets a strong precedent for treatment that may not be obtained from standard forms or assessments. This is particularly important for autistic populations who may have difficulty in attending to their thoughts, feelings, and experiences. Second, the ability to manipulate the VR environment including setting, scenario, noise level, crowdedness, and hostility level is powerful in gradually managing a client’s anxiety and reformulating their interpretations of social situations. Furthermore, this allows a formulation-driven and person-centred approach with VR environments tailored to the specific needs and preferences of the client (Kandalaft et al., 2013). This careful level of control is less tangible with traditional exposure tasks. Third, with pre-set environments ready for use, VR allows for repeated practice, which has been shown to be a powerful adaptation for autistic youths in consolidating learning (Uddin et al., 2024; submitted).

Four participants expressed their interest in VR and technology which incentivised this intervention and their willingness to take part. Autistic populations often present with specific interests including technology which is reported to feel like a safe, comfortable, and enjoyable way of interacting (Valencia, Rusu, Quiñones & Jamet, 2019). VR also provides visually stimulating and interactive environments that can capture the attention of autistic youths unlike traditional talking therapies (Strickland et al., 2018). In this way, VR can be a powerful interface that increases buy-in with CBT, another key finding which was reported by the participants.

Participants also made suggestions for improving the intervention including additional time to practice using the VR to become accustomed to it and for relief from cybersickness. This is important when considering modifications to the intervention and it may be useful to continue to use measures such as the ITC-SOPI (Lessiter et al., 2001) to directly assess for cybersickness, dizziness, and disorientation in future trials. Further improvements included increasing the range of NPC responses in the VR interface, having longer VR scenarios, and having more variety in the VR environment (other than a school). Such feedback is reasonable considering the limited resources and time of a feasibility study meaning only a limited range of VR scenarios could be developed. Again, there is hope for further development of this intervention through a future pilot study and a large-scale RCT, both grounded in the key findings from this study.

Clinical outcome measures

As a case series that includes only five participants, this study was underpowered, and we could not conduct inferential tests for our quantitative outcome measures. Instead, we examined reliable change in anxiety, which highlights observed improvements in symptoms but does not provide any evidence of the intervention's efficacy or effectiveness. Our findings showed that 40% of participants reliably improved in both self-reported (RCADS) and parent-reported (RCADS-P) total anxiety and social phobia subscales at post-intervention and follow-up. Successful goal attainment was also found for three participants (60%) with two of these participants showing further attainment at follow-up. Goals were mostly focused on behavioural change (as this allowed for tangible SMART goals) or improving mental wellbeing with participants successfully increasing school attendance, engagement with hobbies and social activities or managing anxiety. These results are promising, and although one participant did not meet their goals, they reported feeling closer to achieving them with continued support. As previously discussed, participant 3 showed fluctuations in the RCADS and RCAD-P measures and non-attainment of their goals. However, this may reflect a complex anxiety presentation and further demonstrates the need to assess the appropriateness of the intervention across presentations.

These findings are promising for a novel intervention particularly when considered alongside the feasibility data. The two participants who showed reliable change in anxiety symptoms and goal attainment had a 100% completion rate, missed the fewest appointments, and showed a high level of homework compliance. Research too has shown that compliance with CBT sessions is positively correlated to greater reductions in anxiety symptoms in autistic youths (Storch et al., 2013; Wood et al., 2009). As a case series, our study cannot provide any conclusions regarding efficacy, however, this indicates the importance of treatment fidelity.

It is also important to draw parallels between self-reported and parent-reported measures. Generally, parents/guardians in our study reported more severe anxiety symptoms than their child. Research has shown similar discrepancies in reported measures due to differences in perception, communication barriers, and varying levels of insight into internal states for autistic children (De Los Reyes & Kazdin; 2005; Sharma et al., 2021). For this reason, it is important to take measures from multiple informants for a more valid understanding of anxiety symptoms. In the future, studies may also consider clinician-rated and teacher-rated measures to triangulate data and further understand anxiety presentation throughout the course of the intervention.

Clinical and research implications

This study found some promising initial findings regarding the feasibility and acceptability of this novel intervention. While there is growing interest for the use of VR for autistic populations to target social skills, sensory integration, and phobias, this is one of the first studies to explore CBT integrated with VR for social anxiety. A previous study by Maskey et al. (2019) that used VR to augment CBT for phobias in autistic children and adolescents found a reduction in anxiety symptoms and improvements in coping skills. Like our present study, the findings from Maskey and colleagues (2019) showed how VR can support with consolidating CBT skills and encouraging participants to engage with feared stimuli. Together, findings from these studies suggest that VR-CBT may be a useful psychological intervention for autistic adolescents experiencing anxiety. While more research progress is needed before clinical application, the results are promising and may be useful in enhancing the quality of interventions for neurodiverse young people.

It is important to note that as a new intervention, the study used stringent methodology to reliably examine feasibility and acceptability. For example, we devised a manualised therapy protocol that was used with all participants regardless of differences in presentation. This was to ensure that key components of CBT for social anxiety were delivered whilst also controlling for variables other than the VR. However, autistic populations show heterogeneous presentations such as differences in emotion literacy, alexithymia, and sensory difficulties (Simonoff et al., 2008) of which additional CBT sessions can be beneficial. In our study, participants also showed varied presentations on measures such as the TAS-20 and SCQ which was not majorly factored into the intervention. In actual practice, treatment models will need to be tailored according to client presentation and their individual needs.

Improvements suggested by participants should be incorporated in the next stages of development. Participants highlighted the need for a greater variety of VR environments to enhance the relevance and generalisability of the intervention. They emphasised that having a broader range of settings (such as public transport, shopping centres, parks, and public speaking scenarios) would allow for more comprehensive exposure to real-life difficulties and better transfer of learned skills. Incorporating these suggestions will be crucial for future pilot studies. As in the present study’s development phase, engaging stakeholders in the design process is essential to create and refine these environments. Piloting prototypes with service users and their families can provide valuable feedback on their relatability and relevance, ensuring that the VR environments meet the needs of the target population.

Our case series study on VR-CBT for social anxiety in autistic adolescents aligns with the initial phases of complex intervention research as outlined by the updated MRC framework (Skivington et al., 2021). The framework emphasises moving beyond simply asking whether an intervention is effective to a broader range of questions, such as assessing its real-world impact, theorising how it functions, and understanding its scalability (Skivington et al., 2021). Our study contributes to the development and feasibility phases, establishing early insights into how VR-CBT can be useful for this population and key areas for improvement. The next steps, according to the MRC framework, involve evaluation and implementation phases where a pilot acceptability and feasibility study should be conducted before a widescale RCT. This would not only test the intervention's efficacy but would also explore cost-effectiveness and how the intervention might scale across different contexts, including NHS settings (Skivington et al., 2021; Moore et al., 2015).

Furthermore, complex interventions should be examined from efficacy, effectiveness, theory-based and systems perspectives to understand not just outcomes, but also broader impacts, resource requirements, and system-level changes. This framework encourages early collaboration with stakeholders (including service users and policymakers) to ensure that VR-CBT is implementable, scalable, and adaptable in real world practice, bridging the gap between research and actual clinical impact.

With reference to the MRC framework, the next stage in developing and evaluating this intervention should be to examine its use with large and representative samples. Due to limited resources, our study used a small sample size of five participants which was determined without reference to precision around parameter estimates. Consequently, the estimates from this sample are not robust and should not be used to guide decisions on progressing to an RCT. A pilot study should first be conducted to further assess feasibility and acceptability and to provide data for power analyses, which will determine the sample size needed to detect an effect (Gravetter & Forzano, 2016). This approach would allow for more accurate sample size estimates when planning a subsequent, adequately powered RCT. This RCT should compare this novel VR-CBT to a comparator, such as a waitlist or treatment-as-usual (Gravetter & Forzano, 2016). Clinical outcome measures should be collected and compared between treatment groups at multiple time points. With an adequately powered study, researchers can detect significant differences between treatment groups (Gravetter & Forzano, 2016). As the gold-standard design, an RCT, with its rigorous methodology, will provide credible conclusions regarding the efficacy of VR-CBT for social anxiety.

Following RCTs to test the efficacy of VR-CBT, future research should focus on its implementation within NHS settings (Mohr et al., 2017). This is crucial because our study assessed feasibility and acceptability in controlled research environments rather than real clinical settings. To bridge this gap, further research should explore how VR-CBT can be integrated into CAMHS and autism specialist services. This would involve training therapists in VR technology and its integration into clinical practice, while also gathering feedback from therapists, clients, and families. Careful consideration should be given to the cost-effectiveness of VR, including the upfront investment in technology, resource management, potential savings from improved outcomes and reduced burden on services, and long-term financial benefits. As VR technology becomes increasingly affordable and its usability continues to improve, it is becoming more feasible to augment psychological therapy through its use (Slater & Sanchez-Vives, 2016). Evaluations, such as cost-effectiveness analyses, can provide insights into the relative costs and benefits of VR-CBT, which are key to ensuring successful and widespread implementation of VR-CBT within NHS settings (Drummond et al., 2015; NICE, 2013).

Strengths and limitations

To the best of our knowledge, this is one of the first studies to formally assess a one-to-one VR intervention for autistic adolescents experiencing social anxiety. As this was a novel intervention, a case series was deemed appropriate as this allows to elicit feedback on feasibility, acceptability and areas for improvement which can inform future studies.

However, there were some limitations with the interview component of the study. First, we did not interview parents regarding their views of the intervention. Through parents did not engage with the VR themselves, they could have provided vital insights into their child’s functioning and any improvements and challenges. These interviews would have complemented the participant’s own experiences, offering a comprehensive understanding of the use of VR-CBT. Second, it is important to consider the researcher’s position when conducting the participant interviews. Due to the limited time and availability of staff, the same researcher (TU) who delivered the intervention also conducted the interviews. To reduce any bias in reporting, participants were encouraged to be open and honest in their feedback and that positive and negative feedback were welcome. However, subsequent research would benefit from an independent interviewer conducting these interviews to reduce the potential for any researcher bias (Gravetter & Forzano, 2016). Third, our interviews did not include feedback about how appropriate the outcome measures were to the participants or if assessing other behaviours would be more meaningful to them. It is important to gauge from autistic adolescents what outcomes are important to them as this may differ from neurotypical populations. In the future, researchers could utilise co-design groups to support in creating semi-structured interviews and therefore ensure that the interview topics and measures are meaningful.

Another weakness of this study is the absence of a well-defined theory of change for the VR-CBT intervention. According to Zilcha-Mano and Krasovsky (2024), a theory of change is important for understanding how specific therapeutic elements, such as those manipulated through VR, contribute to treatment outcomes. In standard CBT for social anxiety, Clark and Wells' model (1995) posits that therapeutic change occurs via cognitive restructuring (challenging distorted thoughts and beliefs) and behavioural mechanisms (managing avoidance and safety behaviours, and gradual exposure). Without a theory of change for our intervention, the precise ways in which VR might enhance these mechanisms remain unclear. For instance, VR may improve cognitive restructuring by enabling dynamic interactions with characters to challenge distorted beliefs and enhance behavioural experiments through controlled, repeatable exposure to social fears. The absence of a theory of change also limited our semi-structured interviews as the questions we used explored the participants' experience of VR rather than exploring how VR specifically impacted the therapeutic process. A well-developed theory of change would have clarified how VR components align with and potentially enhance CBT mechanisms, providing a clearer understanding of the role of VR in managing social anxiety (Zilcha-Mano & Krasovsky, 2024).

As a case series, this study was limited by the absence of controlled variables and a comparison treatment group, resulting in low internal validity. Consequently, we cannot definitively attribute the observed benefits to VR-CBT specifically, as they could be due to more generic therapeutic effects, which have been shown to account for 30-50% of therapeutic change (e.g., Horvath & Symonds, 1991). However, this may be less critical for the present study, as our goal was to enhance the delivery of established, evidence-based CBT using VR, rather than testing an entirely new intervention. The study should be viewed as exploratory, providing valuable insights into the feasibility and acceptability of VR-CBT for this population, while identifying key steps for further development.

Furthermore, a small sample size limits the generalisability of findings to broader populations. This is particularly salient when we consider that the five participants who completed the intervention were less complex in their presentations when many individuals with autism commonly have comorbidities such as learning disabilities, attention deficit hyperactivity disorder (ADHD), sensory difficulties and other affective disorders (Simonoff et al., 2008). Likewise, almost all participants were from White British backgrounds. This is important as previous research has shown that cultural factors, discrimination, and stigma can impact how individuals with ASD perceive and engage with interventions (Yeh et al., 2016). Furthermore, four of the five participants were male which is important considering the different symptom profiles between genders. For example, females typically show stronger social communication skills but are typically more adept at camouflaging their difficulties than males (Dean et al., 2017; Lai et al., 2019). Hence, a lack of representation in this sample impacts how well our findings apply to the wider autistic adolescent population. The small sample size also meant that demographic data was limited to descriptive analysis, and it was not possible to conduct further analysis here. Once again, this is where a future RCT imperative where it will be possible to recruit a larger, more representative sample and clear conclusions of the applicability to different demographic groups can be made.

The RCI (Jacobson & Truax, 1991) which was used in this study is a valuable tool for assessing individual change on outcome measures. However, it comes with some limitations. The RCI is sensitive to individual change but may lack sensitivity to detect small or subtle changes in scores (Jacobson & Truax, 1991). Another consideration is the use of the baseline standard deviation: high baseline variability can obscure significant changes and how precise the RCI is dependent on the value extracted from previous research and the sample size used for this. It is crucial to interpret the RCI results carefully, keeping in mind both the statistical significance and clinical relevance in the context of individual cases (Jacobson & Truax, 1991).

Conclusions

The findings from this case series tentatively suggest that VR-CBT for social anxiety is feasible and acceptable to autistic adolescents. Reliable change indicated that VR-CBT could potentially improve anxiety symptoms alongside achieving personal goals. These findings contribute to a growing evidence base for the use of VR to assist CBT which can be used to increase engagement with therapies and to enhance treatment such as shared formulation, attention training, behavioural experiments, and graded exposure. However, this study does not provide any evidence regarding the efficacy or effectiveness of the intervention. Efficacy and effectiveness require robust comparisons and controlled studies to establish whether the intervention works better than standard treatments. Therefore, a pilot feasibility and acceptability study should be conducted to inform the parameters for a future RCT. A robust and large-scale RCT could then provide evidence on the efficacy of this intervention. Following this, it will be important to examine the wider implementation of VR-CBT in NHS services. Whilst study limitations have been acknowledged, this is a crucial starting point for a novel intervention in an increasingly digital age. This may serve to improve both access and quality of interventions for autistic adolescents.

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APPENDICES

Appendix 1: Ethical approval

Ymchwil Iechyd a Gofal Cymru
Health and Care Research Wales

NHS
Health Research Authority

Dr Lucia Valmaggia
Reader in Clinical Psychology and Digital Mental Health

& Honorary Consultant Clinical Psychologist
Kings College London, IOPPN
King's College London, IOPPN
Dept of Psychology (PO77), Virtual Reality Lab
De Crespigny Park, Denmark Hill, London
SE5 8AF

Email: approvals@hra.nhs.uk
HCRW.approvals@wales.nhs.uk

24 June 2020

Dear Dr Valmaggia

HRA and Health and Care

Study title:	**Using Virtual Reality Assisted Therapy for Social Anxiety in Adolescents with Autism Spectrum Disorder: A Case Series**
IRAS project ID:	**272006**
REC reference:	**20/LO/0532**
Sponsor	**King's College London**

I am pleased to confirm that **HRA and Health and Care Research Wales (HCRW) Approval** has been given for the above referenced study, on the basis described in the application form, protocol, supporting documentation and any clarifications received. You should not expect to receive anything further relating to this application.

Please now work with participating NHS organisations to confirm capacity and capability, in line with the instructions provided in the "Information to support study set up" section towards the end of this letter.

How should I work with participating NHS/HSC organisations in Northern Ireland and Scotland?

HRA and HCRW Approval does not apply to NHS/HSC organisations within Northern Ireland and Scotland.

If you indicated in your IRAS form that you do have participating organisations in either of these devolved administrations, the final document set and the study wide governance report (including this letter) have been sent to the coordinating centre of each participating nation. The relevant national coordinating function/s will contact you as appropriate.

Please see IRAS Help for information on working with NHS/HSC organisations in Northern Ireland and Scotland.

How should I work with participating non-NHS organisations?

HRA and HCRW Approval does not apply to non-NHS organisations. You should work with your non-NHS organisations to obtain local agreement in accordance with their procedures.

What are my notification responsibilities during the study?

The standard conditions document "*After Ethical Review – guidance for sponsors and investigators*", issued with your REC favourable opinion, gives detailed guidance on reporting expectations for studies, including:

- Registration of research
- Notifying amendments
- Notifying the end of the study

The HRA website also provides guidance on these topics, and is updated in the light of changes in reporting expectations or procedures.

Who should I contact for further information?

Please do not hesitate to contact me for assistance with this application. My contact details are below.

Your IRAS project ID is **272006**. Please quote this on all correspondence.

Yours sincerely,
Georgia Copeland

Approvals Specialist

Email: approvals@hra.nhs.uk

Copy to: *Prof Reza Razavi*

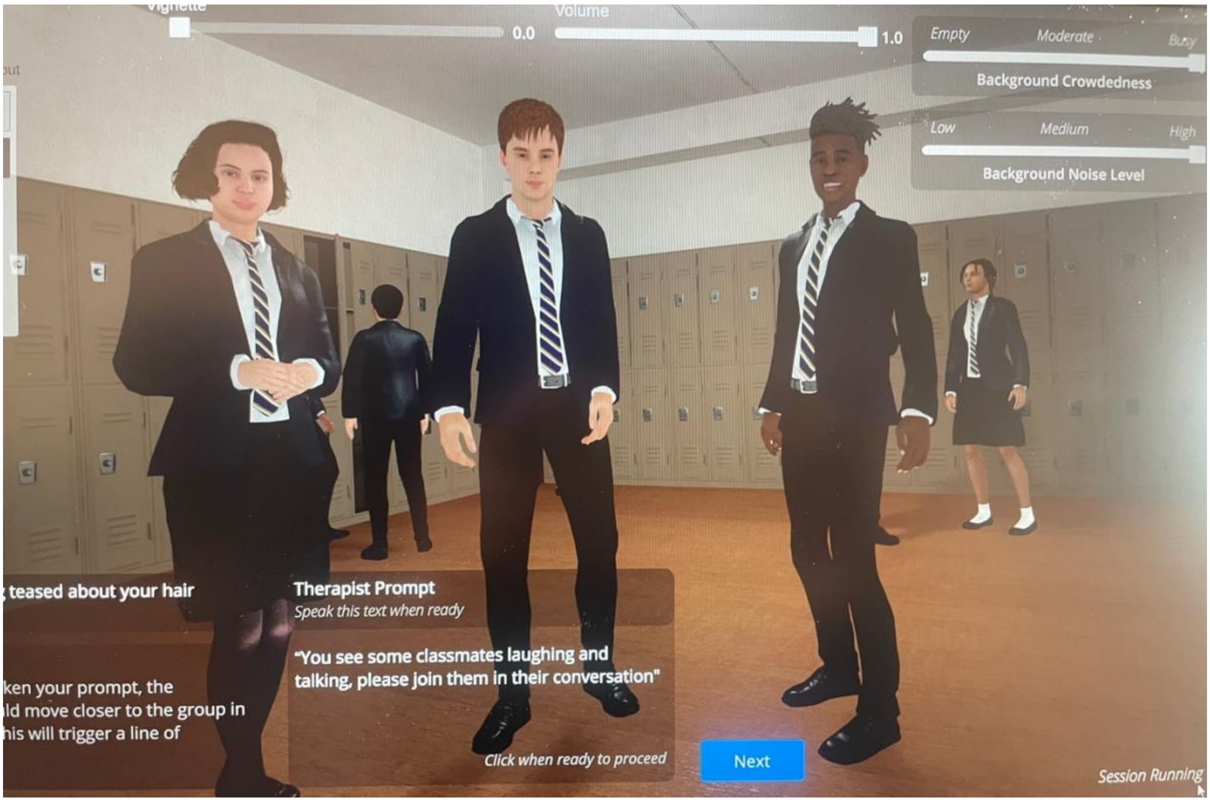
Appendix 2: Sources gathered from literature review for triggers for social anxiety

(from Adams et al., 2022)

Trigger for social anxiety	Exemplar Sources
Unexpected events	(Ambler et al., 2015; Bearss et al., 2016; den Houting et al., 2018; Goodall, 2018; Hare et al., 2015; Humphrey & Lewis, 2008; Kerns et al., 2017; Ozsivadjian et al., 2012; Robertson et al., 2018; Trembath et al., 2012)
Conversing with new/unfamiliar people	(Adams, Simpson, et al., 2020; den Houting et al., 2018; Evans et al., 2005; Maddox & White, 2015; Turner & Romanczyk, 2012)
Doing something new, especially unprepared	(Adams, Simpson, et al., 2020; Bearss et al., 2016; den Houting et al., 2018; Keen et al., 2019; Richman et al., 2012)
Unstructured/uncertain situations with unclear expectations	(Bearss et al., 2016; den Houting et al., 2018; Fogler et al., 2019; Gillott et al., 2001; Halim et al., 2018; Robertson et al., 2018; Simpson et al., 2020; Stuart et al., 2020)
Answering questions (especially ambiguous/open) and unclear communication	(Evans et al., 2005; Stuart et al., 2020; Trembath et al., 2012)
Hostility (including negative social evaluation and performance anxiety)	(Adams, Simpson, et al., 2020; Bearss et al., 2016; den Houting et al., 2018; Evans et al., 2005; Richman et al., 2012; Rodgers et al., 2016; Simpson et al., 2020; Syriopoulou-Delli et al., 2019; Turner & Romanczyk, 2012; Varela et al., 2019)

Interacting with others (inc. groups)	(Arora & Saldivar, 2013; Evans et al., 2005; Halim et al., 2018; Kerns et al., 2016; Robertson et al., 2018; Syriopoulou-Delli et al., 2019; Trembath et al., 2012)
Crowded/busy places	(Adams, Simpson, et al., 2020; Arora & Saldivar, 2013; Bearss et al., 2016; den Houting et al., 2018; Evans et al., 2005; Goodall, 2018; Humphrey & Lewis, 2008; Matson & Love, 1990; Richman et al., 2012; Trembath et al., 2012)

Appendix 3: An example classroom environment and scenario (E. Social invitation)



teased about your hair

ken your prompt, the
ld move closer to the group in
his will trigger a line of

Therapist Prompt
Speak this text when ready

"You see some classmates laughing and talking, please join them in their conversation"

Click when ready to proceed

VR Therapy for Social Anxiety:
Using Virtual Reality to Treat Social Anxiety in Autistic Adolescents

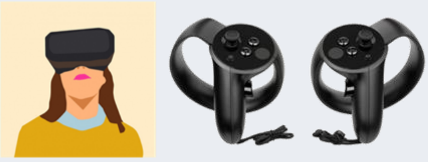
An invitation to take part in **VR Therapy for Social Anxiety** study

Why are we carrying out this study?

Some people can find social situations (e.g. talking to a group of friends) difficult due to anxiety, which is particularly common in young people with Autism Spectrum Disorder (ASD). Anxiety is feeling nervous/scared/worried/frightened. The purpose of this study is to see if we can improve therapy for treating anxiety in autistic people by delivering it in a new way - using virtual reality (VR). If so, more therapists will be encouraged to use VR in the future.

VR is experienced by putting on a headset that shows a computer-made environment that can have characters in it (e.g. a pretend classroom and pupils). It is possible to look around the environment and to interact with the characters in it by moving your head and by using controllers. These controllers are like those from games consoles. VR may make therapy easier for autistic people because:

- rather than being asked to imagine situations that cause anxiety, which can be difficult, situations likely to cause some anxiety can be experienced in VR
- experiencing these VR situations might help people to better identify anxiety and practice ways of coping with anxiety;
- the coping skills learnt in therapy can be practiced in the VR environment, it might become easier to use these skills in everyday situations.



Why have I been given this leaflet?

You are on a waiting list for therapy for anxiety in social situations. The clinical team you are under have decided that you may be suited to VR therapy.

Who is carrying out this study?

The study is led by a team of researchers at King's College London and clinicians at the South London and Maudsley NHS Foundation Trust. Our names are Lucia Valmaggia, Matthew Hollocks, Emily Simonoff and Tasnim Uddin

What will happen if I take part in the VR Therapy for Social Anxiety study?

1. Meet with the researchers.
    - You and your parent or carer will meet with a researcher (Tasnim), and we'll talk about the anxiety you're experiencing.
    - We'll give you some questionnaires so we can learn about your background, know how you're feeling, any difficulties you've experienced in the past and your goals for therapy

2. You'll be able to practice VR.
    - In your own time you can have a go at practicing the VR and getting comfortable with it

3. Therapy begins.
    - You'll have 12 sessions with a trainee therapist. We'll get use to the VR and practice to start. The therapy involves talking about thoughts, feelings and behaviours and using the VR to try out realistic social situations
    - In a safe environment, you'll learn new skills about managing social situations, anxiety and being confident in interacting with others.

4. Meet with the researchers after therapy.
    - To see if the therapy was useful for you, you and your parent/guardian will meet with Tasnim.
    - Tasnim will ask about how you're doing now, how you're feeling and how you found using the VR – be as honest as you can be!
    - You and your parent/guardian will also complete some questionnaires again after therapy and again after 6-weeks. This allows us to see how your mood, anxiety and goals changed before therapy, after therapy and in the long term

I'm interested in the study, so what's next?

- If you are interested let your clinician or therapist know and they will pass your information on to our team – we'll be in contact to give you more information and to arrange our first meeting.

- We'll ask you to sign an Assent Form (if you're under 16) or a consent form (if you're over 16) if you're happy to take part. We'll ask your parent/guardian to fill out similar forms too

- It's completely up to you if you wish to take part and you can withdraw from the study at any time until we finish if you wish to. This won't impact the support you get from your current clinician.

Why is the VR Therapy for Social Anxiety study important?

The findings from this study will mean therapists and other professionals will know:

- whether VR might make therapy easier for autistic people;
- how we can best use VR in therapy;
- what young people think of VR therapy and if they find it useful.

A note about audio recordings

At the end of the study we will complete some interviews. With your permission, the interviews will be audio-recorded. (An audio-recorder is an electronic device, about the size of a mobile phone, which records speech.) You can choose not to be recorded, in which case we will make notes whilst we talk to you.

CONFIDENTIAL

A note about confidentiality

We will not tell anyone (other than your GP and the service that referred you) that you are taking part in this study or what you tell us in the interview. However, if you tell us that you are being hurt or mistreated, we might have to tell someone else to keep you safe.

All the information we collect during the study will be stored securely and will only be seen and used by the research team. All information will be kept strictly confidential in line with the Data Protection Act (DPA) and the General Data Protection Regulation (GDPR).

How will we use information about you?

- We will need to use information from you, your parent/caregiver and your therapist for this research project.
- This information will include your name, age, address, telephone number, date of birth, as well as any specific comments on contacting you. People will use this information to do the research or to check your records to make sure that the research is being done properly.
- King’s College London and South London and Maudsley NHS Foundation trust are the data controllers (i.e. they decide why and how to process/store your data).
- People who do not need to know who you are will not be able to see your name or contact details. Your data will have a code number instead.
- We will keep all information about you safe and secure.
- Once we have finished the study, we will keep some of the data so we can check the results. We will write our reports in a way that no-one can work out that you took part in the study.

Where can you find out more about how your information is used?

You can find out more about how we use your information by asking one of the research team (contact details at the end) or at www.hra.nhs.uk/information-about-patients/.

Statement about insurance cover

In the event that something does go wrong and you, or your parent/caregiver, are harmed during the research you may have grounds for legal action for compensation against King’s College London and/or SLaM NHS Foundation Trust, but you may have to pay your legal costs. The normal National Health Service complaints mechanisms will still be available to you (if appropriate). King’s College London has obtained insurance which provides no-fault compensation i.e. for non-negligent harm, you may be entitled to make a claim for this.

What are your choices about how your information is used?

- You and your parent/caregiver can decide to stop being part of the study at any time, without giving a reason, but we will keep information about you that we already have.
- We need to manage your records in specific ways for the research to be reliable. This means that we won’t be able to let you see or change the data we hold about you.

This study is funded by the Psychiatry Research Trust and Maudsley’s Biomedical Research Centre. The [*specify*] Research Ethics Committee have approved the VR therapy study [*ref no.*]. IRAS ID: 272006

The VR therapy study team is based at the Institute of Psychiatry, Psychology and Neuroscience, King’s College London, Denmark Hill, London, SE5 8BB. If you have any queries, please use the contact details on the next page.

If you have any concerns about this study, or wish to make a complaint, please contact:
Prof Reza Razavi, Vice President & Vice Principal (Research), 57 Waterloo Road, King’s College London, London, SE1 8WA. Email: reza.razavi@kcl.ac.uk Tel: (0)207 8483224

OR Gill Dale, Director of Research Quality, SLaM/IoPPN R&D Office, PO BOX 05, Institute of Psychiatry, Psychology & Neuroscience, King’s College London, London, SE5 8AF. Email: gill.dale@kcl.ac.uk

Contact Details

If you require further information, please ask your parent/caregiver about contacting us in the following ways:

Tasnim Uddin (Trainee Clinical Psychologist)
Email: **tasnim.1.uddin@kcl.ac.uk**

Or

Dr Lucia Valmaggia
Email: **lucia.valmaggia@kcl.ac.uk**
Phone: **020 7848 5003**

Participant Information Sheet: Parents or guardians
Using Virtual Reality to Treat Social Anxiety in Autistic Adolescents

01/09/2023

Chief Investigator: Dr Lucia Valmaggia
Principle Investigator at South London and Maudsley: Prof. Emily Simonoff
Principal Investigator at Guy's and St Thomas': Dr Lauren Taylor
Ethics reference: 20/LO/0532
IRAS ID: 272006

We would like to invite you to take part in our research study.
Before you decide whether to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with your son/daughter, or the young person aged under 16 for whom you have parental responsibility for, if you wish. Ask us if there is anything that is not clear or if you would like more information (see last page for contact details). Please take time to decide whether you and your child wish to take part.

What is the purpose of the study?

Some people can find social situations (e.g. talking to a group of friends) difficult due to anxiety, which is particularly common in young people with ASD. Anxiety is feeling nervous/scared/worried/frightened. Anxiety can be treated using cognitive behavioural therapy (CBT), but autistic people can find CBT difficult to engage with.

It may be possible to make CBT easier and more helpful for autistic people by using virtual reality (VR). For example, rather than asking the person to imagine situations they feel anxious in, which can be difficult for someone with autism, the person can experience situations likely to cause anxiety in VR instead. VR is experienced by putting on a headset that shows a computer-made environment that can have characters in it (e.g. a pretend classroom and pupils). It is possible to look around the environment and to interact with the characters in it by moving your head and by using controllers. These controllers are like those from games consoles. The therapist can teach the person coping skills whilst in the VR social situations to reduce any feelings of anxiety. This may make it easier for the person to cope in everyday social situations.

We want to see if VR can improve CBT for young people with ASD who feel anxious in social situations. If VR assisted CBT is perceived as beneficial, data from this project will be also used to support a larger application to the National Institute for Health Research with the aim of generating evidence base that can further support long-lasting policy changes. The psychologists who deliver the therapy as part of this project will be encouraged to implement VR in their therapy, wherever this is compatible with their duties.

Why has your child been invited?

Your child has been invited to take part because they are on a waiting list for psychological therapies in the relevant NHS service and/or have previously indicated that they experience anxiety in social situations and would like some support with this. The clinical team managing your child's care thinks he/she would be suitable to take part in terms of the difficulties he/she is experiencing.

Taking part in the study will not affect your child's medical care or rights in any way. The waiting list for standard psychological therapies can be several months. If you chose for them to take part in this research study, your child will remain on the waiting list for standard psychological therapies at their local service whilst they participate in this research study. They will also still be able to access to standard psychological interventions at their local service once they are at the top of the waiting list.

What will happen?

Firstly, we will check with your referrer that your child meets the eligibility criteria for joining the study and that there is no reason why VR would not be suitable for them. Your referrer may be your child's care co-ordinator or the clinician they see in your local mental health service. We will then check that you and your child still want to take part. If you both agree to participate, we will collect some information about your child. This will include information about your child's ASD and how this diagnosis was made.

Initial appointment

If you decide that you wish to take part in our research, we will arrange an appointment with you and your child, at a time that is convenient for you. In the initial appointment, you will be able to discuss the study with the researcher and ask any questions you may have. The researcher will ask you and your child about their anxiety, everyday functioning, and other relevant questions. If you and your child decide to take part, we will ask you both to complete some consent forms.

Questionnaires

If you decide to take part, we will ask you and your child to complete some questionnaires before your child starts the therapy. The questionnaires you will be asked to fill out will include questions about your demographic information, your child's general mental health, how they communicate with others, their daily functioning and their anxiety and their mood. The questionnaires your child will be asked to fill out independently will include questions on their ability to identify their own emotions, any sensory sensitivities, their general mental health and about their anxiety and mood. If you or your child haven't been able to fill out all the questionnaires before their first therapy appointment, we will ask that you arrive early to the appointment to complete any incomplete questionnaires.

What will the therapy involve?
Your child will be offered 12 sessions VR-CBT sessions, as required for their clinical needs. The therapy will be delivered by a trainee clinical psychologist. The therapy is very similar to what your child may have received from routine services with the main difference being that it will involve VR. The therapy sessions will start with information on anxiety in the context of ASD, what to expect from the therapy, and learning how to identify emotions. During these first sessions, VR will be introduced using relaxing scenes before being used for session content. For the later sessions, your child will explore their feelings of social anxiety and how to manage this whilst also using VR. This includes your child experiences social situations simulated in VR that may cause some feelings of anxiety whilst being taught coping skills. This will start from the least challenging social situation, and they will work towards more challenging social situations across sessions, as agreed between the therapist and your child.

At the beginning of therapy, as would normally be the case, your child and the therapist will agree therapy goals that your child will work towards both within and outside of therapy. During the first and last use of VR your child will be asked to fill out a questionnaire on their experiences that will take approximately 10 minutes.

Questionnaires and interviews after therapy
After therapy and six weeks later, we will ask you and your child to complete the same set of questionnaires about their anxiety and mood which was completed when they first started this therapy. At these points, your child will also be asked to rate their progress on the goals that they set when they first started this therapy.

After the last therapy session, to see if this intervention has been useful, the researcher will interview you and your child either in-person or online using Microsoft Teams. They will ask your child about how they found the therapy, specifically the VR including what was helpful and unhelpful and if they have any suggestions for improving this intervention. We'll ask your child to be as honest as they can. This interview will take approximately 30-45 minutes.

A note about audio recordings
We find recording interviews allows us to have a complete record of the interview. With your permission, the interviews will be audio-recorded (using Microsoft Teams). You can choose for you and/or your child not to be audio-recorded, in which case we will make notes whilst we talk to you. We may quote you and/or your child, but we won't include your name or any information that could be used to identify you.

Do I have to take part?

It is up to you and your child whether or not you would like to take part. Your involvement in the research is entirely voluntary. If you do decide you would like to take part, you are free to withdraw from the research study at any time. You do not need to give us a reason if you no longer wish to take part. If your child turns 16 years old during the study, they will be asked to consent for themselves.

If you do decide to withdraw yourself or your child from the study, we would like to continue to use any information that you have provided up until that point. If you decide for your child to discontinue the therapy, we would also like to ask you and your child to complete any remaining questionnaires at the usual timepoints, but this will be up to you. It is important for you to know that you and your child's involvement in this study will not have any impact on the support that you or your child are currently receiving from your child's clinician or any support that you or your child may receive in the future.

What happens to my information?

We will follow ethical and legal practice and all information about you and your child will be handled in confidence.

If you and your child join the study, data collected for the study will be looked at by authorised individuals from King's College London who are organising this research. It may also be looked at by authorised individuals to check that the study is being carried out correctly. All will have a duty of confidentiality to you as research participants and we will do our best to meet this duty. Your GP will be informed by your clinician of your child's or young person's participation in the study.

All information that is collected about you and your child during the research will be kept **strictly confidential**, stored in a secure and locked office, and on a password-protected database.

Any information about you and your child will have your name and address removed (anonymised) and a unique code will be used so that you cannot be recognised from it.

We will ask you whether you and your child wish to be contacted about any future research projects that you and your child may be interested in participating in. You and your child are not obliged to agree to be contacted for future research. If you do agree to be contacted, you and your child are not obliged to take part in any future studies we may tell you about. You can request for your own and your child's details to be deleted at any time.

If you would like information about the results of the study once it has ended, please feel free to contact the research team using the details at the end of the information sheet. Alternatively, your and your child's personal data (address, telephone number) will be kept for 7 years, in accordance with the rules of clinical trials, after the end of the study so that we are able to contact you ourselves about the findings of the study. We will keep details for longer if you agree to be contacted about future research. After this time your data will be disposed of securely. During this time all precautions will be taken by all those involved to maintain your confidentiality, only members of the research team will have access to your personal data.

How will we use information about you?

- We will need to use information from you, your child and your child's therapist for this research project.
- This information will include you and your child's name, age, address, telephone number, date of birth, as well as any specific comments on contacting you. People will use this information to do the research or to check your records to make sure that the research is being done properly.
- King's College London and South London and Maudsley NHS Foundation trust are the data controllers (i.e. they decide why and how to process/store your data).
- People who do not need to know who you are will not be able to see your name or contact details. Your data will have a code number instead.
- We will keep all information about you safe and secure.
- Once we have finished the study, we will keep some of the data so we can check the results. We will write our reports in a way that no-one can work out that you took part in the study.

What are your choices about how your information is used?

- You can stop being part of the study at any time, without giving a reason, but we will keep information about you that we already have.
- We need to manage your records in specific ways for the research to be reliable. This means that we won't be able to let you see or change the data we hold about you.

Where can you find out more about how your information is used?

You can find out more about how we use your information by asking one of the research team (contact details at the end) or at www.hra.nhs.uk/information-about-patients/

When might confidentiality be broken?

Although the information you and your child give is kept confidential, should you or your child disclose anything which we feel puts you, your child, or anyone else at any risk, we may feel it necessary to report this to the appropriate persons. This is uncommon and we would expect to obtain your consent first to share this information.

Possible risks or disadvantages of taking part

There is very little risk associated with this study but participating in this research will take up some of your time. We will require you to find some time to respond to questionnaires, interviews, and tests. Where possible, we will administer questionnaires and interviews over-the-phone, online or when you are at the clinic for an appointment. If we ask you to visit our research site, or your clinic at a time when you don't otherwise have an appointment, we will reimburse your travel expenses.

Benefits

We are evaluating whether VR makes CBT easier and more helpful for young autistic people. If it does, your child should find it easier to identify when they are anxious and to cope with anxiety in everyday social situations. The therapy is evidence-based, and VR therapy has been shown to be promising for treating anxiety and social functioning in other patient groups, including in people with ASD.

What if there is a problem?

If you have a concern about any aspect of this study, you should ask to speak to the researchers who will do their best to answer your questions. The researchers' contact details are given at the end of this information sheet. If you remain unhappy and wish to complain formally, you can do this by contacting NHS Complaints through your local Patient Advice and Liaison Service (PALS), South London and Maudsley NHS Foundation Trust at pals@slam.nhs.uk or on 0800 731 2864. Alternatively, you can contact Gill Dale, Director of Research Quality, SLaM/IoPPN R&D Office, PO BOX 05, Institute of Psychiatry, Psychology & Neuroscience, King's College London, London, SE5 8AF. Email: gill.dale@kcl.ac.uk.

Statement about insurance cover

If something does go wrong and you, or your child, are harmed during the research you may have grounds for legal action for compensation against King's College London and/or SLaM NHS Foundation Trust, but you may have to pay your legal costs. The normal National Health Service complaints mechanisms will still be available to you (if appropriate). King's College London has obtained insurance which provides no-fault compensation i.e. for non-negligent harm, you may be entitled to make a claim for this.

Who is organising and funding the research?

This research is being funded by the Psychiatry Research Trust, a charitable organisation which funds mental health research, as well as the National Institute for Health Research (NIHR) Maudsley Biomedical Research Centre (BRC) which funds research on new tests/treatments/theories in mental health. The research is being carried out by King's College London, at the Institute of Psychiatry, Psychology and Neuroscience, and the South London and Maudsley NHS Foundation Trust.

Who has reviewed the study?

All research in the NHS is looked at by an independent group of people, called a Research Ethics Committee, to protect your interests. This study has been reviewed and given favourable opinion by: *Dulwich Research Ethics committee* (REC ref: 20/LO/0532)

Contact details

If you require further information, please contact:
Tasnim Uddin
Trainee Clinical Psychologist
Email: tasnim.1.uddin@kcl.ac.uk

Or

Dr Lucia Valmaggia
Email: lucia.valmaggia@kcl.ac.uk
Phone: 020 7848 5003
Reader in clinical psychology and Digital Mental Health & Honorary Consultant Clinical Psychologist

Postal address:
PhD Research Office B4.10
Addiction Sciences Building, Institute of Psychiatry, Psychology & Neuroscience (IoPPN)
4 Windsor Walk, Denmark Hill, London
London
SE5 8BB

Appendix 5: Consent/assent forms for participants and parents/guardians

Institute of Psychiatry

at the Maudsley

Institute of Psychiatry
Child & Adolescent
Psychiatry
De Crespigny Park
London SE5 8AF
Tel 020 7848 5368
Fax 020 7708 5800
www.kcl.ac.uk/iop

KING'S College LONDON

Virtual reality assisted cognitive behavioural therapy for social anxiety in autistic adolescents: A case series

Researcher: Tasnim Uddin (tasnim.1.uddin@kcl.ac.uk)

Assent to participate from young person aged under 16 years

Please enter your date of birth to confirm that you are aged under 16 years (e.g. 17/02/2006). __/__/_____

Participant Identification Number: **Please initial or tick each box**

1. I confirm I am under 16 years of age. ☐
2. I confirm that I have read and understood the information sheet for the above study. I have had the opportunity to consider the information, ask questions, and have had these answered satisfactorily. ☐
3. I understand that participation is voluntary, and my parent/caregiver is free to withdraw me at any time without giving any reason and without my medical care or legal rights being affected. ☐
4. I understand that relevant sections of my medical notes and data collected during the study may be looked at by individuals from King's College London, from regulatory authorities or from the NHS Trust, where it is relevant to my taking part in this research. I give permission for these individuals to have access to my records. ☐
5. I understand that if I am withdrawn from the study any data already collected would be retained and used in the study. ☐
6. I agree to allow the researcher to make an audio recording of the interviews. ☐
7. I agree for quotes from my interview to be used in published reports. these quotes would not reveal who I am. ☐

8. I understand that if there are significant concerns about me or someone else’s safety, the research team may deem it necessary to share information with my care team or the relevant authorities. ☐

9. I agree to take part in the above study. ☐

10. I agree to being contacted on an ongoing basis for the study. ☐

11. I agree to my GP being notified of my participation in this study. ☐

(Optional) I agree to being contacted by the research team about future research after I have participated in the study and for my contact details to be retained for this reason. ☐

(Optional) I would like to be sent a short report of findings from the study. ☐

Name of Participant	Date	Signature

Name of researcher taking assent	Date	Signature

IRAS Project ID: 272006

Institute of Psychiatry

at the Maudsley

Institute of Psychiatry
Child & Adolescent
Psychiatry
De Crespigny Park
London SE5 8AF
Tel 020 7848 5368
Fax 020 7708 5800
www.kcl.ac.uk/iop

KING'S College LONDON

Virtual reality assisted cognitive behavioural therapy for social anxiety in autistic adolescents: A case series

Researcher: Tasnim Uddin (tasnim.1.uddin@kcl.ac.uk)

Consent to participate from young person aged 16 years or over

Please enter your date of birth to confirm that you are aged 16 years or over (e.g. 17/02/2004). __/__/_____

Participant Identification Number: **Please initial or tick each box**

1. I confirm I am 16 years of age or over. ☐

2. I confirm that I have read and understood the information sheet for The above study. I have had the opportunity to consider the information, ask questions, and have had these answered satisfactorily. ☐

3. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected. ☐

4. I understand that relevant sections of my medical notes and data collected during the study may be looked at by individuals from King's College London, from regulatory authorities or from the NHS Trust, where it is relevant to my taking part in this research.
I give permission for these individuals to have access to my records. ☐

5. I understand that if I withdraw from the study any data already collected would be retained and used in the study. ☐

6. I agree to allow the researcher to make an audio recording of the interviews. ☐

7. I agree to direct anonymised quotations from interviews being ☐

published in reports.

8. I understand that if there are significant concerns about me or someone else's safety, the research team may deem it necessary to share information with my care team or the relevant authorities. ☐

9. I agree to take part in the above study. ☐

10. I agree to being contacted on an ongoing basis for the study. ☐

11. I agree to my GP being notified of my participation in the study. ☐

(Optional) I agree to being contacted by the research team about future research after I have participated in the study and for my contact details to be retained for this reason. ☐

(Optional) I would like to be sent a short report of findings from the study. ☐

Name of Participant	Date	Signature
Name of researcher taking consent	Date	Signature

IRAS Project ID: 272006

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KING'S College LONDON

Virtual reality assisted cognitive behavioural therapy for social anxiety in autistic adolescents: A case series

Researcher: Tasnim Uddin (tasnim.1.uddin@kcl.ac.uk)

Consent to participate from parents, or caregivers with parental responsibility, for young people aged under 16 years

Participant Identification Number: **Please initial or tick each box**

1. I confirm I have parental responsibility for the child I am consenting for. ☐

2. I confirm that I have read and understood the information sheer for The above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

3. I understand that my child's participation is voluntary and that they are free to withdraw at any time up until they have completed the intervention without giving any reason, without their medical care or legal rights being affected. ☐

4. I understand that relevant sections of my child’s medical notes and data collected during the study may be looked at by individuals from King’s College London, from regulatory authorities or from the NHS Trust, where it is relevant to their taking part in this research. I give permission for these individuals to have access to my child’s records. ☐

5. I understand that if my child withdraws from the study any data already collected would be retained and used in the study. ☐

6. I agree to allow the researcher to make an audio recording of the Interviews with my child. ☐

7. I agree to direct anonymised quotations from the interviews being published in reports. ☐

8. I understand that if there are significant concerns about my child or someone else’s safety, the research team may deem it necessary to share information with my child’s care team or the relevant authorities. ☐

9. I agree for my child to take part in the above study. ☐

10. I agree to being contacted on an ongoing basis for the study. ☐

11. I agree for my child’s GP being notified of their participation in the study ☐

(Optional) I agree to being contacted by the research team about future research after my child has participated in the study and for my contact details to be retained for this reason. ☐

(Optional) I would like to be sent a short report of findings from the study. ☐

____
Name of participant

Name of Parent/guardian	Date	Signature
Name of researcher taking consent	Date	Signature

IRAS Project ID: 272006

Institute of Psychiatry

at the Maudsley

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Child & Adolescent
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Tel 020 7848 5368
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KING'S College LONDON

Virtual reality assisted cognitive behavioural therapy for social anxiety in autistic adolescents: A case series

Researcher: Tasnim Uddin (tasnim.1.uddin@kcl.ac.uk)

Consent to participate for parents, or caregivers of young person aged 16 years and over

Participant Identification Number: **Please initial or tick each box**

1. I confirm I have parental responsibility for the child I am consenting for. ☐
2. I confirm that I have read and understood the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐
3. I understand that my child's participation is voluntary and that they are free to withdraw at any time up until they have completed the intervention without giving any reason, without their medical care or legal rights being affected. ☐
4. I understand that relevant sections of my child's medical notes and data collected during the study may be looked at by individuals from King's College London, from regulatory authorities or from the NHS Trust, where it is relevant to their taking part in this research. I give permission for these individuals to have access to my child's records. ☐
5. I understand that if I withdraw from the study any data already collected would be retained and used in the study. ☐
6. I agree to allow the researcher to make an audio recording of the Interviews with my child. ☐

7. I agree to direct anonymised quotations from the interviews being published in reports. ☐

8. I understand that if there are significant concerns about my child or someone else's safety, the research team may deem it necessary to share information with my child's care team or the relevant authorities. ☐

9. I agree for my child to take part in the above study. ☐

10. I agree to being contacted on an ongoing basis for the study. ☐

11. I agree for my child's GP being notified of their participation in the study ☐

(Optional) I agree to being contacted by the research team about future research after my child has participated in the study and for my contact details to be retained for this reason. ☐

(Optional) I would like to be sent a short report of findings from the study. ☐

____
Name of participant

Name of Parent/guardian	Date	Signature
Name of researcher taking consent	Date	Signature

IRAS Project ID: 272006

Appendix 6: Therapy protocol

VR-CBT for social anxiety in autistic adolescents
Therapist guide

Session 1

AIMS:
- Building a rapport with the client
- Lay the foundation for a strong therapeutic alliance
- Psychoeducation surrounding autism spectrum disorders (ASD)
    - Tailor information from the ASD psychoeducation sheet and discuss how this presents for the individual client
- Set treatment goals – SMART Goals
- Explain the rationale for Virtual Reality assisted cognitive behaviour therapy (VR-CBT) and practice using VR “wait room”
    - Introduce the concept of VR-CBT; VR can be used to simulate social situations in a controlled environment to practice and manage anxiety.
    - Highlight how VR can support by gradually exposing the client to social scenarios, reducing anxiety through experiential learning, skills training, attention training etc.

MATERIALS:
- VR equipment
- Goal Attainment Scaling (GAS) sheet
- ASD psychoeducation materials
- *Autism and Me* worksheet

HOMEWORK:
- Explain the importance of homework in therapy, set regular times for completion
- Review autism and me worksheet with parents/guardians (optional)

Session 2

AIMS:
- Further develop therapeutic alliance
- Psychoeducation of social anxiety (SA) in the context of ASD
    - Share and discuss information on how ASD may influence social experiences and social anxiety. This includes discussing challenges with interaction and communication, sensory sensitivities, and communication styles associated with ASD
- Develop an individualised formulation using the cognitive model (Clark & Wells, 1995)
    - select a VR scenario that is relevant to the participant’s presentation and preference

    - Identify main feared and avoided situations, thoughts, anxiety symptoms, self-focus, safety behaviours, images, pre-and post-event processing

MATERIALS:

- VR equipment
- Body Map
- SA psychoeducation
- Blank formulation sheet

HOMEWORK:

- Elaborate and consolidate cognitive model with parents/guardians – formulation copy provided to review, add, and amend details.
- Recreate the model on blank formulation sheets with parent/guardian and document formulation of any new social anxiety-provoking situations encountered

Session 3

AIMS:

- Exploring emotions including recognition and regulation (refer to participant's TAS-20 score and any previous psychology input on this, adapt accordingly)
- Develop shared understanding and language surrounding emotions
- Understanding and recognising how emotions in others present
    - bring in characters/special interests to help identify, understand and react to emotions
    - use body map and/or faces and emotion cue worksheets to convey how emotions present
- Regulation of difficult emotions
    - introducing and practising techniques such as deep breathing exercises to help the client cope with emotional distress and improve self-regulation.

MATERIALS:

- Feeling thermometer
- Body map
- Faces and emotions cues

HOMEWORK:

- N/A

Session 4

AIMS:

- Use a social story (can incorporate special interests/characters if preferred) to explain the concept of safety behaviours and their role in maintaining the cycle of social anxiety
- Using and dropping safety behaviours using VR → <u>scenario impromptu speech, asking a question, social invitation</u>

    - jointly identify and experience the client’s safety behaviours in action
    - discuss the pros and cons of each safety behaviour and its role in social anxiety
    - practice scenarios again whilst dropping safety behaviours (may need multiple practices)

MATERIALS:
- VR equipment
- Blank social story strip
- Safety behaviours experiment record sheet

HOMEWORK:
- Continue to practice dropping safety behaviours in real world social situations identified with parent/guardian and document on blank safety behaviours experiment record sheet

Session 5

AIMS:
- Use/identify feared situations (refer to formulation)
- Identify useful VR scenarios to be used (hostile and non-hostile) to activate this fear
    - Before VR, discuss and document client’s predictions about their performance
    - Complete VR scenario
    - After VR ask the client to rate performance and anxiety
    - Review and discuss predictions made vs reality, use of safety behaviours and maintenance of anxiety
    - Repeat where necessary

MATERIALS:
- VR equipment
- Record sheet for behavioural experiments

HOMEWORK:
- Set and carry out behavioural experiments with parent/guardian in the real world, complete record sheet for behavioural experiments

Session 6

AIMS:
- Attention training and relaxation
- Discuss the importance of shifting attention
    - shifting focus externally to reduce anxiety and provide accurate self-perception
- Encourage attention towards concrete cues (visual or audio external cues)
- Practice brief training exercises using a structured approach - sounds, colours, shadows/textures, music, or therapist reading

- Practice using this attention shift in VR (hostile situation e.g., teasing, conversation with authority figure, rule breaking)

MATERIALS
- Brief training scripts, music, sensory equipment, books (depending on participant's choice of exercise)
- VR equipment

HOMEWORK
- Practice shifting attention with an agreed upon script/stimuli in two settings:
    - alone/with parent/guardian to consolidate learning
    - during social interactions (focusing on the conversation rather than self-perception)
- Take notes for discussion in the next session

Session 7-10
AIMS:
- Create an exposure hierarchy based on the participant's fearful concern (session 7 only)
    - List feared situations
    - Rate anxiety prediction for each situation and rank from least to most anxiety-provoking, use VR scenarios for reference
- Continue to use VR for gradual exposure and to reinforce social skills
    - gradually increase the level of difficulty (hostility level, noise level, crowdedness) as discussed with the client
    - focus on tangible behaviours to promote change (social cues, safety behaviours, interactions)
    - jointly review client predictions and performance
- Continue to review learning from experiments and homework exposure tasks to encourage cognitive restructuring

MATERIALS:
- VR equipment
- Record sheet for exposure tasks

HOMEWORK:
- Set manageable homework tasks based on exposure hierarchy with participant and parent/guardian
- Carry out exposure (with parent/guardian if required) in the real world each week, complete the record sheet to review in session

Session 11
AIMS:
- This session is flexible to focus on the participant's needs and can be used for:

    - Problem-solving (should problems arise from behavioural experiments or exposure hierarchy) or
    - Further focus on cognitive restructuring (support for those experiencing negative thoughts) or
    - Continuing with exposure hierarchy and experiments

MATERIALS:
- VR equipment
- Problem-solving sheet
- Thought record sheet
- Record sheet for exposure tasks

HOMEWORK:
- Continue to carry out exposure (with parent/guardian if required) in the real world, complete the record sheet to review in session

Session 12
AIMS:
- Introduce relapse prevention
    - Explain the importance of managing setbacks and consolidating skills learned in therapy
- Create therapy blueprint
    - Explore initial difficulties, maintenance, what was learned in therapy (noting unhelpful beliefs and helpful alternatives), progress made, challenges and steps to overcome these, future goals
    - Final VR walkthrough, to consolidate strategies learned and steps for the future
- Engage parents in reviewing the therapy blueprint and in supporting their child with ongoing practice
- Review therapy goals and complete RCADS/RCADS-P

MATERIALS:
- VR equipment
- Therapy blueprint
- GAS sheet (initially completed at session 1)

HOMEWORK:
- N/A

Appendix 7: Social Communication Questionnaire

(SCQ; Rutter et al., 2003)

Social Communication Questionnaire (English Version)

Answers YES or NO

Name of subject:

Date of birth:

Date of interview:

Chronological age:

Gender:

Thank you for taking the time to complete the questionnaire. This questionnaire asks about the behaviour of your child in the last three months. Please answer each question with a yes or a no. A few questions ask about several similar behaviours; please answer yes if any of these behaviours have been present. Even if you are uncertain about whether some behaviours were present or not, please answer yes or no to every question on the basis of what you think.

1. Is she/he now able to talk using short phrases or sentences?

If no skip to question 8.

2. Do you have a to and fro “conversation” with your child that involves taking turns or building on what you have said?

3. Does your child ever use odd phrases or say the same thing over and over in almost exactly the same way (either phrases that she/he hears other people use or ones that she/he makes up)?

4. Does your child ever use socially inappropriate questions or statements? For example, does she/he ever regularly ask personal questions or make personal comments at awkward times?

5. Does your child ever get her/his pronouns mixed up (e.g. saying you or she/he for I)?

6. Does your child ever use words that she/he seems to have invented or made up her/himself put things in odd, indirect ways (e.g. saying hot rain for steam)?

7. Does your child ever say the same thing over and over in exactly the same way or insist that you say the same thing over and over again?

8. Does your child ever have things that she/he seems to have to do in a very particular way or order or routines that she/he insists that you go through?

9. Does your child’s facial expression usually match the particular situation, as far as

you can tell?

10. Does your child ever use your hand like a tool or as if it were a part of her/his own body (e.g. pointing with your finger or putting your hand on a doorknob to get you to open the door)?

11. Does your child have any interests that take up a lot of her/his time and might seem odd to other people (e.g. robots (traffic lights), taps or counting)?

12. Does your child ever seem to be more interested in parts of a toy or an object (e.g. spinning the wheels of a car), rather than in using the object as it is meant to be used?

13. Does your child ever have any special interests that are unusual in their intensity, but otherwise appropriate for her/his age and peer group (e.g. trains, dinosaurs, soccer teams, Generations)?

14. Does your child ever seem to be unusually interested in the sight, feel, sound, taste, or smell of things or people?

15. Does your child ever have any mannerism or odd ways of moving her/his hands or fingers, such as flapping or moving her/his fingers in front of her/his eyes?

16. Does your child ever have any unusual movements of her/his whole body, such as spinning or repeatedly bouncing up and down?

17. Does your child ever injure her/himself deliberately, such as by biting her/his arm or banging her/his head?

18. Does your child ever have any objects (other than a soft toy, teddy bear or blanket that she/he likes) that she/he has to carry around?

19. Does your child have any particular friends or a best friend?

20. Does your child ever talk with you just to be friendly (rather than to get something)?

21. Does your child ever just copy you (or other people) or what you are doing (such as sweeping, vacuuming, washing dishes, cleaning the yard, or mending things)?

22. Does your child ever just point at things around her/him just to show you things (not because she/he wants them)?

23. Does your child ever use gestures, other than pointing or pulling you hand, to let you know what she/he wants?

24. Does your child nod her/his head to show yes?

25. Does your child shake her/his head to show no?

26. Does your child usually look at you directly in the face when doing things with you or talking with you?

27. Does your child smile back if someone smiles at her/him?

28. Does your child ever show you things that interest him/her to catch your attention?

29. Does your child ever offer to share things other than food with you?

30. Does your child ever seem to want you to join in her/his enjoyment of something?

31. Does your child ever try to comfort you if you are sad or hurt?

32. If your child wants something or wants help, does she/he look at you and use gestures with sounds or words to get your attention?

33. Does your child show a normal range of facial expressions?

34. Does your child ever just join in and try to copy the actions in social games, such as The Mulberry Bush, Ring-a-Rosy, Wheels on the Bus or London Bridge is Falling Down, On-On or clapping games?

35. Does your child play any pretend or make-believe games (like playing house)?

36. Does your child seem interested in other children of about the same age that she/he does not know?

37. Does your child react well when another child approaches her/him?

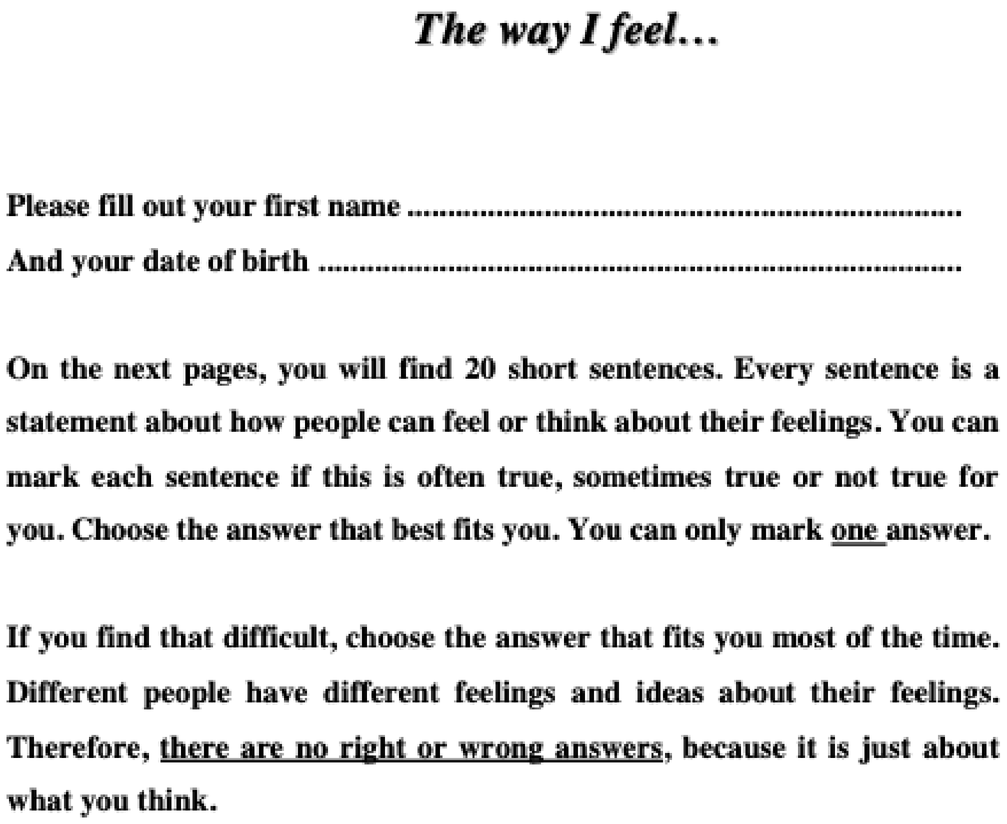
38. If you come into a room and start talking to your child without calling her/his name, does she/he usually look up and pay attention to you?

39. Does your child ever play pretend games with another child in such a way that you can tell that each child understands what the other is pretending?

40. Does your child play nicely in group games with other children, such as hide-and-seek or ball games?

Appendix 8: Toronto Alexithymia Scale

(TAS-20; Bagby et al., 2006)



The way I feel…

Please fill out your first name ....

And your date of birth ....

On the next pages, you will find 20 short sentences. Every sentence is a statement about how people can feel or think about their feelings. You can mark each sentence if this is often true, sometimes true or not true for you. Choose the answer that best fits you. You can only mark one answer.

If you find that difficult, choose the answer that fits you most of the time. Different people have different feelings and ideas about their feelings. Therefore, there are no right or wrong answers, because it is just about what you think.

		Not true	Some-times true	Often true
1	**I am often confused about the way I am feeling inside**	☐	☐	☐
2	**I find it difficult to say how I feel inside**	☐	☐	☐
3	**I feel things in my body that even doctors don’t understand**	☐	☐	☐
4	**I can easily say how I feel inside**	☐	☐	☐
5	**When I have a problem, I want to know where it comes from and not just talk about it**	☐	☐	☐
6	**When I am upset, I don’t know if I am sad, scared or angry**	☐	☐	☐
7	**I am often puzzled by things that I feel in my body**	☐	☐	☐
8	**I’d rather wait and see what happens, instead of thinking about why things happen**	☐	☐	☐
9	**Sometimes I can’t find the words to say how I feel inside**	☐	☐	☐
10	**It is important to understand how you feel inside**	☐	☐	☐
11	**I find it hard to say how I feel about other people**	☐	☐	☐
12	**Other people tell me that I should talk more about how I feel inside**	☐	☐	☐
13	**I don’t know what’s going on inside me**	☐	☐	☐
14	**I often don’t know why I am angry**	☐	☐	☐
15	**I prefer talking to people about everyday things, rather than about how they feel**	☐	☐	☐

		Not true	Sometimes true	Often true
16	**I prefer watching funny television programmes, rather than films that tell a story about other people's problems**	☐	☐	☐
17	**It is difficult for me to say how I really feel inside, even to my best friend**	☐	☐	☐
18	**I can feel close to someone, even when we are sitting still and not saying anything**	☐	☐	☐
19	**Thinking about how I feel, helps me when I want to do something about my problems**	☐	☐	☐
20	**When I have to concentrate on a film to understand the story, I enjoy the film much less**	☐	☐	☐

Please check
that you have marked all of the
sentences.

Thank you!

Appendix 9: Interview questions for participants

Topic guide for the qualitative semi-structured interviews

Have participant's ICT-SOPI from first VR session and final VR session to hand.

Intro:
Thank you for completing the intervention with us and for taking part in this interview. This interview should last around 20-30 minutes although this can vary. Please answer each question as honestly as you can – we will record your answer but keep your identity anonymous. Your responses will let us know what is good about VR-CBT and what we need to improve for when we use it in the future.

1. What, if anything, did you like about the therapy and why?
2. What, if anything, did you dislike about the therapy and why?
3. What, if anything, was helpful about the therapy and why?
4. What, if anything, was unhelpful about the therapy and why?
5. Do you have any suggestions for improving the therapy?
6. Were the virtual reality scenarios realistic? (e.g. probe about the NPC's behaviour, the conversations and situations)
7. Did you feel like the characters were reacting to you? Did you feel able to assess their reactions (e.g. their opinion of you)? (if unable, discuss comparing this ability in VR to that in real-life)
8. (Refer to participant's ITC-SOPI responses for dizziness, disorientation and nausea) How did you feel the first time you used the VR? How did you feel the final time you used the VR?
9. Were the virtual reality scenarios useful?
10. Do you have any suggestions for improving the virtual reality scenarios and environments?

End:
Thank you for taking part in the interview. Did you have any other comments about the intervention? Do you have any questions?

Appendix 10: Information and Communications Technology Sense of Presence Inventory short version

(ITC-SOPI; Lessiter et al., 2001)

ITC SOPI

Please read the instructions below before continuing

Instructions:
We are interested in finding out what you feel about the experience you have just had with virtual reality. Some of the questions refer to the content of the displayed environment. By this we mean the story, settings, or events, or whatever you could see, hear, or sense happening within the virtual reality.

The first question asks you about your thoughts and feelings once the displayed environment was over. The remaining questions ask you about your thoughts and feelings while you were experiencing the displayed environment. Please do not spend too much time on any one question. Your first response is usually the best. For each question, choose the answer closest to your own.

Please remember that there are no right or wrong answers – we are simply interested in your thoughts and feelings about the displayed environment. Please do not discuss the questionnaire with anyone who may also complete it as this may affect your answers or theirs.

Please indicate HOW MUCH YOU AGREE OR DISAGREE with each of the following statements by circling just ONE of the numbers using the 5-point scale below.

(Strongly Disagree)	**(Disagree)**	**(Neither Agree nor Disagree)**	**(Agree)**	**(Strongly Agree)**
1	**2**	**3**	**4**	**5**

AFTER MY EXPERIENCE OF THE DISPLAYED ENVIRONMENT…

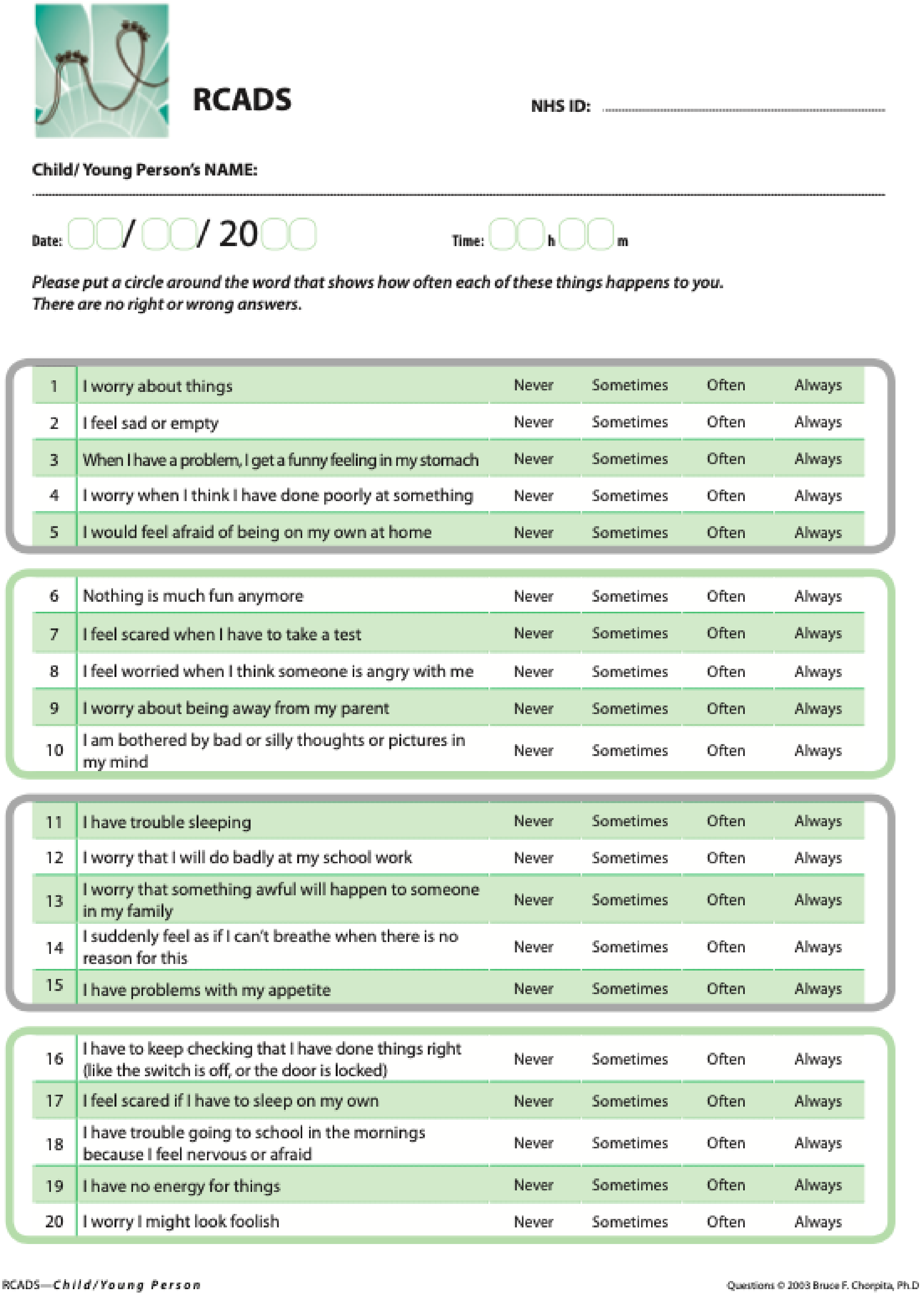
I felt disoriented	1 2 3 4 5

DURING MY EXPERIENCE OF THE DISPLAYED ENVIRONMENT…

I felt myself being 'drawn in'	1 2 3 4 5
I lost track of time	1 2 3 4 5
The displayed environment seemed natural	1 2 3 4 5
I felt I was visiting the places in the displayed environment	1 2 3 4 5
The content seemed believable to me	1 2 3 4 5
I felt dizzy	1 2 3 4 5
I felt that the displayed environment was part of the real world	1 2 3 4 5
I paid more attention to the displayed environment than I did to my own thoughts (e.g. personal preoccupations, daydreams)	1 2 3 4 5
I had a sense of being in the scenes displayed	1 2 3 4 5
I felt surrounded by the displayed environment	1 2 3 4 5
I felt nauseous	1 2 3 4 5

Appendix 11: The Revised Children's Anxiety and Depression Scale

(RCADS; Chorpita et al., 2000)



RCADS

NHS ID: ....

Child/ Young Person's NAME:

....

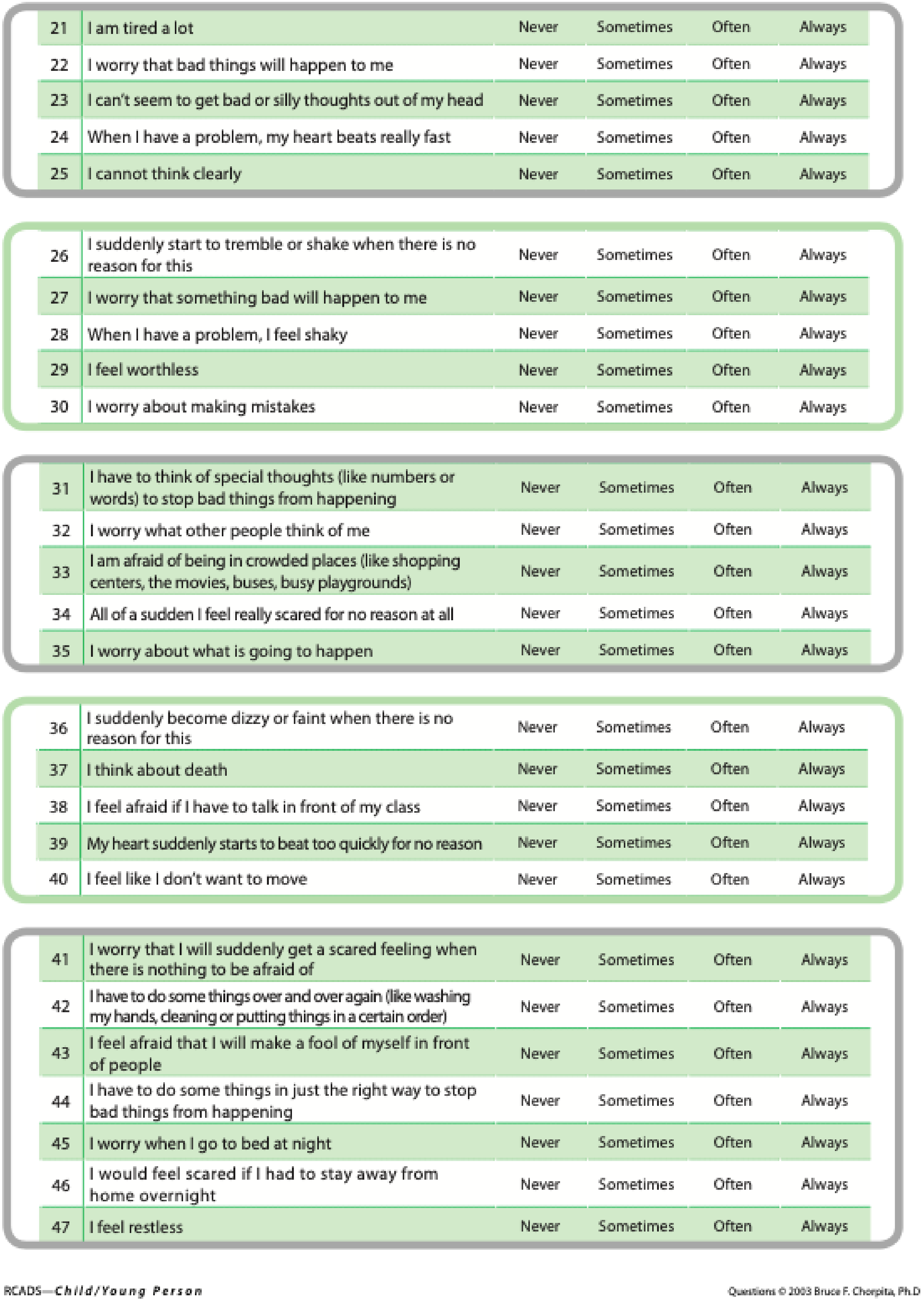
Date: ☐☐/☐☐/ 20☐☐ **Time:** ☐☐h☐☐m

Please put a circle around the word that shows how often each of these things happens to you.
There are no right or wrong answers.

1	I worry about things	Never	Sometimes	Often	Always
2	I feel sad or empty	Never	Sometimes	Often	Always
3	When I have a problem, I get a funny feeling in my stomach	Never	Sometimes	Often	Always
4	I worry when I think I have done poorly at something	Never	Sometimes	Often	Always
5	I would feel afraid of being on my own at home	Never	Sometimes	Often	Always
6	Nothing is much fun anymore	Never	Sometimes	Often	Always
7	I feel scared when I have to take a test	Never	Sometimes	Often	Always
8	I feel worried when I think someone is angry with me	Never	Sometimes	Often	Always
9	I worry about being away from my parent	Never	Sometimes	Often	Always
10	I am bothered by bad or silly thoughts or pictures in my mind	Never	Sometimes	Often	Always
11	I have trouble sleeping	Never	Sometimes	Often	Always
12	I worry that I will do badly at my school work	Never	Sometimes	Often	Always
13	I worry that something awful will happen to someone in my family	Never	Sometimes	Often	Always
14	I suddenly feel as if I can't breathe when there is no reason for this	Never	Sometimes	Often	Always
15	I have problems with my appetite	Never	Sometimes	Often	Always
16	I have to keep checking that I have done things right (like the switch is off, or the door is locked)	Never	Sometimes	Often	Always
17	I feel scared if I have to sleep on my own	Never	Sometimes	Often	Always
18	I have trouble going to school in the mornings because I feel nervous or afraid	Never	Sometimes	Often	Always
19	I have no energy for things	Never	Sometimes	Often	Always
20	I worry I might look foolish	Never	Sometimes	Often	Always

RCADS—*Child/Young Person*

Questions © 2003 Bruce F. Chorpita, Ph.D



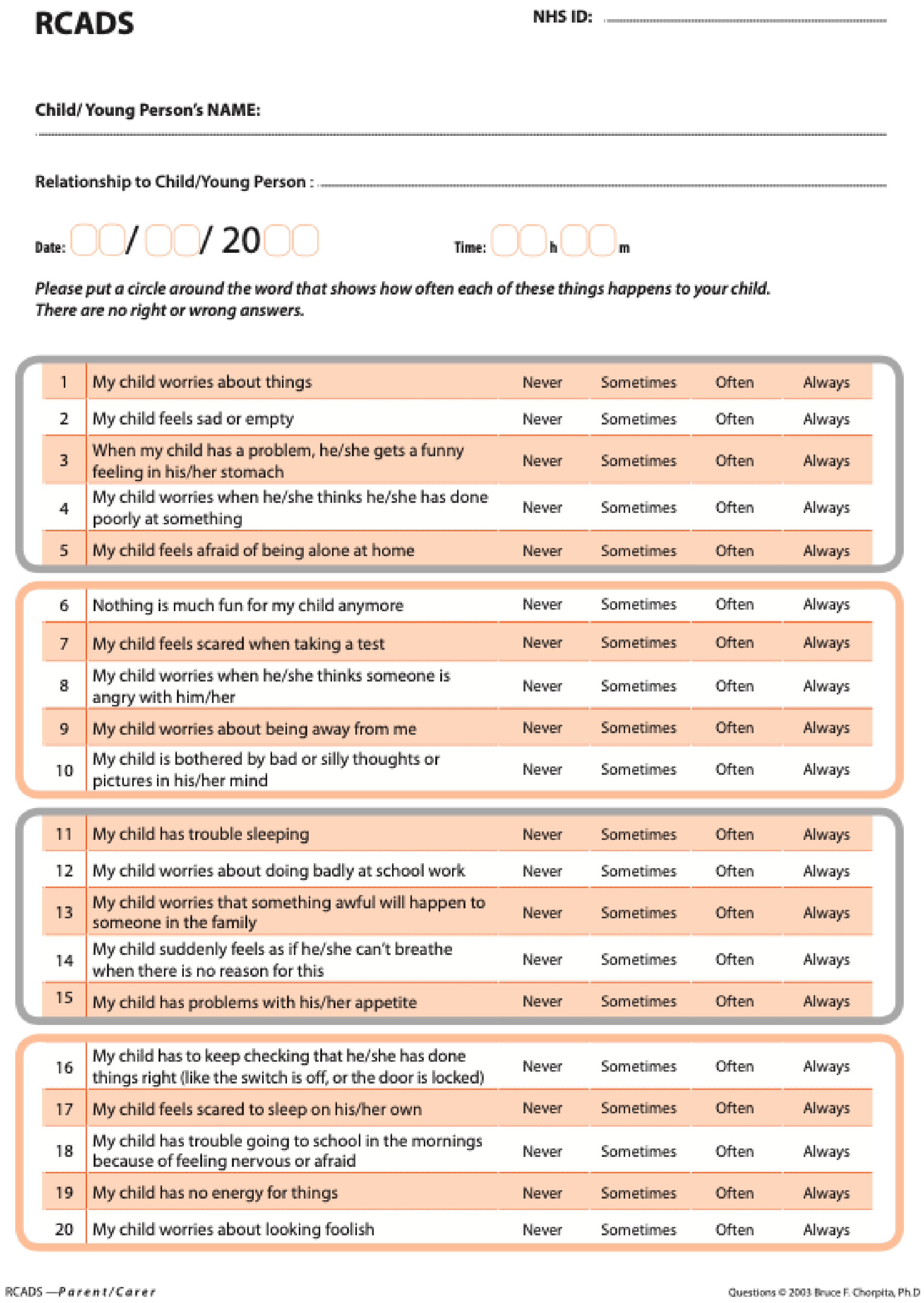
21	I am tired a lot	Never	Sometimes	Often	Always
22	I worry that bad things will happen to me	Never	Sometimes	Often	Always
23	I can't seem to get bad or silly thoughts out of my head	Never	Sometimes	Often	Always
24	When I have a problem, my heart beats really fast	Never	Sometimes	Often	Always
25	I cannot think clearly	Never	Sometimes	Often	Always
26	I suddenly start to tremble or shake when there is no reason for this	Never	Sometimes	Often	Always
27	I worry that something bad will happen to me	Never	Sometimes	Often	Always
28	When I have a problem, I feel shaky	Never	Sometimes	Often	Always
29	I feel worthless	Never	Sometimes	Often	Always
30	I worry about making mistakes	Never	Sometimes	Often	Always
31	I have to think of special thoughts (like numbers or words) to stop bad things from happening	Never	Sometimes	Often	Always
32	I worry what other people think of me	Never	Sometimes	Often	Always
33	I am afraid of being in crowded places (like shopping centers, the movies, buses, busy playgrounds)	Never	Sometimes	Often	Always
34	All of a sudden I feel really scared for no reason at all	Never	Sometimes	Often	Always
35	I worry about what is going to happen	Never	Sometimes	Often	Always
36	I suddenly become dizzy or faint when there is no reason for this	Never	Sometimes	Often	Always
37	I think about death	Never	Sometimes	Often	Always
38	I feel afraid if I have to talk in front of my class	Never	Sometimes	Often	Always
39	My heart suddenly starts to beat too quickly for no reason	Never	Sometimes	Often	Always
40	I feel like I don't want to move	Never	Sometimes	Often	Always
41	I worry that I will suddenly get a scared feeling when there is nothing to be afraid of	Never	Sometimes	Often	Always
42	I have to do some things over and over again (like washing my hands, cleaning or putting things in a certain order)	Never	Sometimes	Often	Always
43	I feel afraid that I will make a fool of myself in front of people	Never	Sometimes	Often	Always
44	I have to do some things in just the right way to stop bad things from happening	Never	Sometimes	Often	Always
45	I worry when I go to bed at night	Never	Sometimes	Often	Always
46	I would feel scared if I had to stay away from home overnight	Never	Sometimes	Often	Always
47	I feel restless	Never	Sometimes	Often	Always

RCADS—*Child/Young Person*

Questions © 2003 Bruce F. Chorpita, Ph.D

Appendix 12: The Revised Child Anxiety and Depression Scale – Parent Version

(RCADS-P; Chorpita et al., 2000)



RCADS

NHS ID: ....

Child/ Young Person's NAME:

....

Relationship to Child/Young Person : ....

Date: ☐☐/ ☐☐/ 20☐☐ **Time:** ☐☐**h**☐☐**m**

Please put a circle around the word that shows how often each of these things happens to your child.
There are no right or wrong answers.

1	My child worries about things	Never	Sometimes	Often	Always
2	My child feels sad or empty	Never	Sometimes	Often	Always
3	When my child has a problem, he/she gets a funny feeling in his/her stomach	Never	Sometimes	Often	Always
4	My child worries when he/she thinks he/she has done poorly at something	Never	Sometimes	Often	Always
5	My child feels afraid of being alone at home	Never	Sometimes	Often	Always
6	Nothing is much fun for my child anymore	Never	Sometimes	Often	Always
7	My child feels scared when taking a test	Never	Sometimes	Often	Always
8	My child worries when he/she thinks someone is angry with him/her	Never	Sometimes	Often	Always
9	My child worries about being away from me	Never	Sometimes	Often	Always
10	My child is bothered by bad or silly thoughts or pictures in his/her mind	Never	Sometimes	Often	Always
11	My child has trouble sleeping	Never	Sometimes	Often	Always
12	My child worries about doing badly at school work	Never	Sometimes	Often	Always
13	My child worries that something awful will happen to someone in the family	Never	Sometimes	Often	Always
14	My child suddenly feels as if he/she can't breathe when there is no reason for this	Never	Sometimes	Often	Always
15	My child has problems with his/her appetite	Never	Sometimes	Often	Always
16	My child has to keep checking that he/she has done things right (like the switch is off, or the door is locked)	Never	Sometimes	Often	Always
17	My child feels scared to sleep on his/her own	Never	Sometimes	Often	Always
18	My child has trouble going to school in the mornings because of feeling nervous or afraid	Never	Sometimes	Often	Always
19	My child has no energy for things	Never	Sometimes	Often	Always
20	My child worries about looking foolish	Never	Sometimes	Often	Always

RCADS —*Parent/Carer*

21	My child is tired a lot	Never	Sometimes	Often	Always
22	My child worries that bad things will happen to him/her	Never	Sometimes	Often	Always
23	My child can't seem to get bad or silly thoughts out of his/her head	Never	Sometimes	Often	Always
24	When my child has a problem, his/her heart beats really fast	Never	Sometimes	Often	Always
25	My child cannot think clearly	Never	Sometimes	Often	Always

26	My child suddenly starts to tremble or shake when there is no reason for this	Never	Sometimes	Often	Always
27	My child worries that something bad will happen to him/her	Never	Sometimes	Often	Always
28	When my child has a problem, he/she feels shaky	Never	Sometimes	Often	Always
29	My child feels worthless	Never	Sometimes	Often	Always
30	My child worries about making mistakes	Never	Sometimes	Often	Always

31	My child has to think of special thoughts (like numbers or words) to stop bad things from happening	Never	Sometimes	Often	Always
32	My child worries what other people think of him/her	Never	Sometimes	Often	Always
33	My child is afraid of being in crowded places (like shopping centers, the movies, buses, busy playgrounds)	Never	Sometimes	Often	Always
34	All of a sudden my child will feel really scared for no reason at all	Never	Sometimes	Often	Always
35	My child worries about what is going to happen	Never	Sometimes	Often	Always

36	My child suddenly becomes dizzy or faint when there is no reason for this	Never	Sometimes	Often	Always
37	My child thinks about death	Never	Sometimes	Often	Always
38	My child feels afraid if he/she have to talk in front of the class	Never	Sometimes	Often	Always
39	My child's heart suddenly starts to beat too quickly for no reason	Never	Sometimes	Often	Always
40	My child feels like he/she doesn't want to move	Never	Sometimes	Often	Always

41	My child worries that he/she will suddenly get a scared feeling when there is nothing to be afraid of	Never	Sometimes	Often	Always
42	My child has to do some things over and over again (like washing hands, cleaning, or putting things in a certain order)	Never	Sometimes	Often	Always
43	My child feels afraid that he/she will make a fool of him/herself in front of people	Never	Sometimes	Often	Always
44	My child has to do some things in just the right way to stop bad things from happening	Never	Sometimes	Often	Always
45	My child worries when in bed at night	Never	Sometimes	Often	Always
46	My child would feel scared if he/she had to stay away from home overnight	Never	Sometimes	Often	Always
47	My child feels restless	Never	Sometimes	Often	Always

Appendix 13: Goal Attainment Scaling

(GAS; Kiresuk & Sherman, 1968; Turner-Strokes, 2009)

: Date:	*Participant ID:*	*Researcher initials:*

Goal Attainment Scale Record Sheet

	Baseline				
	Participant stated goal (and brief description of current situation)	**SMART Goal**	**Imp**	**Diff**	**Baseline**
1			0 1 2 3	0 1 2 3	☐ **Some** function (-1) ☐ **None** (as bad as can be) (-2)
2			0 1 2 3	0 1 2 3	☐ **Some** function (-1) ☐ **None** (as bad as can be) (-2)
3			0 1 2 3	0 1 2 3	☐ **Some** function (-1) ☐ **None** (as bad as can be) (-2)

Introduction

1. Before completing GAS

We would now like to ask you what you might like to change or achieve in your life within the next 3-9 months. I would like to set some specific goals with you that you can work towards during this time.

Possible avenues for exploration:

a) Work/studying
b) Leisure activities
c) Social life
d) Other interests

2. Possible questions to ask to establish **participant stated goal**:

- What would you like to be different in your life?
- If you were to change one thing in your life what would it be?

3. Possible questions to ask to establish **SMART goal**:

- What do you need to do to achieve this goal (participant stated goal)?
- What would be the barriers to achieving this goal (participant stated goal)?

Make sure that all goals are SPECIFIC, MEASUREABLE, ACHIEVEABLE, REALISTIC and TIME-FRAMED. At the same time, goal needs to be repeatable, as the outcome is rated post-therapy.

Instructions: State goals and pre-specify the outcomes

#	Goal	Worse than expected	Same as baseline	Partially achieved	Fully Achieved	Better than expected
		-2	-1	0	+1	+2
1						
2						
3						

	Baseline	**Post – Therapy**		
#	**SMART Goal**	**Achieved**	**Outcome**	**Additional information/Context** *(describe achievement if differs from expected and give reasons)*
1		☐ Yes	☐ Better ☐ **Fully achieved** ☐ Partially achieved	
		☐ No	☐ Same as baseline ☐ Worse	
2		☐ Yes	☐ Better ☐ **Fully achieved** ☐ Partially achieved	
		☐ No	☐ Same as baseline ☐ Worse	
3		☐ Yes	☐ Better ☐ **Fully achieved** ☐ Partially achieved	
		☐ No	☐ Same as baseline ☐ Worse	

Instructions

Goal	Importance		Difficulty		Baseline		Achieved	Outcome	
SMART	0	Not at all (important)	0	Not at all (difficult)	-1	Some (function)	Yes	+2	Better than expected
								+1	Fully achieved
								0	Partially achieved
S - Specific	1	A little (important)	1	A little (difficult)	-2	None (as bad as can be)	No	-1	Same as baseline
								-2	Worse than expected
M - Measurable	2	Moderately (important)	2	Moderately (difficult)					
A – Achievable	3	Very (important)	3	Very (difficult)					
R - Realistic									
T – Time-framed									