An intervention for fears and phobias in young people with autism spectrum disorders using flat screen computer-delivered virtual reality and cognitive behaviour therapy

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ABSTRACT

Background: Specific fears and phobias are common in young people with autism spectrum disorder (ASD) and can impact greatly on daily functioning. Traditional treatment methods, such as real-life or imaginal exposure, may not be suitable for this population without adaptation and alternative interventions are needed. In previous studies, we established that delivering graded exposure through computer generated scenes in a fully immersive virtual reality environment (the Blue Room) is an effective intervention for some young people with ASD and specific fears/phobias. In this study, we explored the same intervention delivered using flat screen, computer-delivered virtual reality graded exposure with cognitive behavioural therapy.
Methods: Eight young people with ASD received one psychoeducation session followed by four 20 minute sessions of flat screen, computer–delivered virtual reality graded exposure with cognitive behaviour therapy (CBT) sessions with a psychologist. Follow up measures, including Target Behaviour change ratings, were taken at 6 weeks, 6 months and 12 months after intervention.
Results: Four of the participants were classed as responders to the intervention and were able to function without the fear/phobia impacting their life. These improvements were maintained 12 months post-intervention. One participant was lost to follow-up and three participants were classed as non-responders to the intervention.
Conclusions: Findings show that flat screen computer-delivered virtual reality with cognitive behaviour therapy can be an effective intervention for specific fears and phobias for some young people with ASD.

Added value of this study

We report a trial of a virtual reality (VR) treatment for specific phobia in young people with ASD. The study adds to the evidence

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base regarding treatments of phobia/fear in ASD. Eight young people with ASD received one psychoeducation session followed by four 20 minute sessions of flat screen computer–delivered virtual reality graded exposure with cognitive behaviour therapy (CBT) sessions with a therapist. Follow up measures were taken at 6 weeks, six months and 12 months after intervention. The results suggest that the treatment can be effective for some children in helping manage their real life targeted phobia/fear, with four of the participants classed as responders to the intervention and were able to function without the fear/phobia impacting their life. These improvements were maintained 12 months post intervention.

The VR treatment exemplifies adaptations to CBT recommended in NICE Guideline 170 in order to make treatment more effective for children with ASD.

1. Introduction

Autism spectrum disorder (ASD) is a common neurodevelopmental disorder which is often associated with co-existing mental health conditions, such as anxiety (Maskey, Warnell, Parr, Le Couteur, & McConachie, 2013; van Steensel, Bögels, & Perrin, 2011). Anxiety in those with ASD is associated with significant social, emotional and economic impact (McPheeters, Davis, Navarre, & Scott, 2011). One type of anxiety - specific fears and phobia - is commonly experienced by autistic people (Mayes et al., 2013). Specific fears and phobias (hereafter termed phobias) are characterised by an excessive and persistent fear of a specific object or situation that interferes with an individual's daily functioning (American Psychiatric Association, 2013). Phobias can lead to avoidance of everyday situations and reduced participation opportunities (Maskey, Lowry, Rodgers, McConachie, & Parr, 2014; Maskey et al., 2018a submitted; Maskey et al., 2018b submitted). Some of the phobias reported by people with ASD are similar to those reported in the general population e.g. dogs, heights or spiders; however phobias experienced by people with ASD may also include more atypical fears e.g. of vacuum cleaners, specific foods or babies crying or supermarkets. Phobias have been shown to be more prevalent and more varied in ASD than in typically developing children and young people (Lydon, Healy, O'Callaghan, Mulhern, & Holloway, 2015; Mayes et al., 2013). A close association between phobias in ASD and challenging behaviour has also been reported (Evans, Canavera, Kleinpeter, Maccubbin, & Taga, 2005; Lydon et al., 2015).

The recommended method of treatment for phobias in the general population is cognitive behavioural therapy (CBT), including graded exposure to the feared stimuli (either through real life or imagination). Some studies have described the successful use of CBT for children with autism (Ung, Selles, Small, & Storch, 2015; Walters, Loades, & Russell, 2016); however this treatment may pose specific difficulties for autistic people. Real life exposure can be too anxiety-provoking to allow treatment to take place and imaginal exposure may be challenging for autistic individuals who experience deficits in imagination (Lind, Williams, Bowler, & Peel, 2014; Low, Goddard, & Melser, 2009).

One alternative method to in-vivo or imaginal exposure to the phobic stimulus is the use of virtual reality. That is, computer-generated virtual images/scenes of the feared object or situation are delivered in a graded manner to provide the exposure. Virtual reality as a method of treatment delivery is gaining popularity (Botella, Fernández-Álvarez, Guillén, García-Palacios, & Baños, 2017) and has been used to treat a variety of clinical conditions in the neuro typical population, including specific phobias. However, there has been little work on this type of intervention for those with ASD.

New interventions for fears/phobias in young people with ASD are needed. The UK National Institute for Health and Care Excellence (NICE) published guidelines suggest that CBT may be appropriate for children with ASD but with some adaptations (NICE, 2013). Adaptations recommended include: emotion recognition training, greater use of written and visual information and structured worksheets, a more cognitively concrete and structured approach, simplified cognitive activities, involving parents/carers to support the implementation of the intervention, maintaining attention by offering regular breaks and incorporating the young person's special interests into the therapy if possible.

In line with these recommendations, we have developed an intervention for individuals with ASD that uses cognitive behaviour therapy, including graded exposure, delivered in a virtual reality setting to reduce the anxiety associated with a phobia (Maskey et al., 2014; Maskey et al., 2018a submitted; Maskey et al., 2018b submitted). In previous studies with autistic young people and adults we have used a totally immersive virtual reality environment (VRE), known as the Blue Room, which uses audio visual images projected onto the walls and ceilings of a 360˚ seamless screened room (Maskey et al., 2014; Maskey et al. 2018a submitted; Maskey et al., 2018b submitted); the treatment and research programme has been developed in partnership with the Blue Room owners Third Eye Neurotech. Participants are not required to wear a headset or goggles; using controls on an iPad, the participant can seem to move around the room freely, interacting and navigating through the scenario at their own discretion. The treatment involves one psychoeducation session followed by four 20 minute sessions of graded exposure to a specified phobic stimulus in the Blue Room. Participants are accompanied by a psychologist who supports the young person with ASD to utilise relaxation techniques and positive self-talk. Computer-generated scenes are individualised for each participant's specific fear/phobia. Parents/carers are able to observe the session remotely from an adjacent room with an ASD research practitioner present.

The results from three immersive VRE studies (Maskey et al., 2014; Maskey et al., 2018a submitted; Maskey et al., 2018b submitted) provide support for the use of this intervention for individuals with ASD. However, the immersive VRE equipment needed means participants have to travel to a Blue Room facility for treatment. We therefore wanted to investigate an alternative method of delivery of the virtual images. The aims of this small observational study were to investigate whether the anxiety reduction seen following fully immersive VRE treatment could be achieved through delivery of the intervention via a flat screen presentation of individualised computer-generated images with the support of a psychologist, and whether there might be justification for a future, larger scale randomised trial. We therefore worked with a small group of children to evaluate whether flat screen computer delivery of images had any potential for anxiety reduction.

2. Methods

2.1. Participants

Eight verbally fluent males with a clinical ASD diagnosis and no reported learning disability, aged 8 to 12 years old, were recruited (recruitment age specified on information sheets was 8–14 years). The lower age range was so that participants had the ability to reflect on their experience and access the CBT techniques and the upper limit was to avoid recruiting children during important national exam years. Recruitment was from the research Database of children with Autism Spectrum Disorder living in the North East (Dasl^{n}e) (McConachie et al., 2009), held at Newcastle University. Parents/carers had consented to receiving information about research studies at the time of joining the database. Recruitment from the database was via mail-out of an information sheet and expression of interest form to families of young people within the age range who lived within the vicinity of Newcastle University and could therefore travel for treatment. All responses received were from parents of males. At the time of joining the database, parents provide details of their child's clinical ASD diagnosis and this was independently corroborated by the local National Health Service multidisciplinary team clinicians who made that diagnosis. Clinical multidisciplinary teams in the North East of England follow best practice as laid down in guidelines from the UK National Institute for Health and Clinical Excellence (NICE, 2011). All of the children included in the study were identified by the clinical research team as experiencing a fear or phobia which was interfering with daily life, as described by the parents and child.

All parents completed the Social Communication Questionnaire (SCQ) at the time of consent (Berument, Rutter, Lord, Pickles, & Bailey, 1999); all children's scores were compatible with an ASD diagnosis (mean = 20.9; SD = 5.2) (Eaves, Wingert, & Ho, 2006). All children had a specific phobia/fear for which the team were able to create a visual scenario (see Table 1). One child had an additional diagnosis of ADHD.

Ethics Statement

A positive Ethics opinion and approval of the study was given by Sunderland NRES Committee North East Research Ethics Committee (reference 12/NE/0018, Substantial Amendment 2).

2.2. Measures

The following measures were taken at baseline and at 6 weeks, 6 months and 12 months after the intervention:

Spence Children's Anxiety Scale-parent version (SCAS-P) and child version (SCAS-C): The SCAS (Spence, 1998) was developed to assess anxiety symptoms in children in the general population. The SCAS-C has 44 items on a 0 (never) to 3 (always) scale and comprises six subscales, including panic attack and agoraphobia, separation anxiety disorder, social phobia, physical injury fears, obsessive compulsive disorder and generalized anxiety disorder. Six items are positively worded filler items (excluded from the parent version). The SCAS shows high internal consistency, for the total scale, and each subscale (Spence, 1998) and good validity, for example, distinguishing between groups of typically developing children with and without anxiety disorder (Nauta et al., 2004).

Target Behaviours: Standardized scales may not include the exact item(s) of most concern to the participant or their caregivers, and may fail to reflect real change important to the individual family (Arnold et al., 2003; Scahill et al., 2017). The Target Behaviours approach was used to record change over time for anxiety relating to a specific situation. The protocol used was developed by The Research Units on Paediatric Psychopharmacology and involves working with families to identify one or two problem/target behaviours. Further details can be found in Arnold et al. (2003) and our previous publication ((Maskey et al., 2014) but briefly: Identifying target behaviours includes asking questions such as 'how often?', 'how distressed?' and 'how does it interfere with daily activities?' asked in a standard format to the parent and child, to enable a vignette to be written about target behaviours and their severity/impact. In our study, the baseline vignette was collected at the initial home visits and the follow up vignettes (at 6 weeks, 6 months and 12 months post intervention) were collected from parents/carers via email report of their child's behaviour in the target situation. Pairs of vignettes from baseline and 6 weeks, 6 months and 12 months after the end of treatment were compared by an expert panel of 4 raters to assess the degree of change in the target behaviour from baseline on a 9 point scale, from 'normalised' (1 on scale) to 'disastrously worse' (9 on scale). Arnold et al., reported an inter rater reliability of 0.9. Those whose paired vignettes (baseline vignette with a time point post-treatment) were rated on average 3 or less (corresponding to 'definitely improved' or better) were classed as responders to treatment. Hence baseline scores are not created; the score reflects progress at a stated time point compared with baseline description. The panel were blinded as to the identity and time period since the intervention; the research assistant who collected the vignettes was not blind to time since intervention.

The measure below was taken during treatment:

Confidence ratings: Children rated their confidence at tackling their behavioural goal (see below) immediately before session 1, at the end of session 2, at the beginning of session 3 and at the end of session 4. Parents also rated their perception of the child's confidence at the same time points, having observed the sessions through a one-way screen. Ratings were from 0 (not at all comfortable) to 6 (very comfortable). Examples of a confidence rating scale for a child afraid of dogs is shown in Fig. 1 (child's scale).

2.3. Research and treatment procedures

After receipt of the Expression of Interest, the first author met with the young person and their parents at home to explain the study, respond to any questions and obtain informed written consent and assent from both the child and their parents/guardians. Baseline questionnaires were also undertaken with parent and child.

Table 1

Presenting phobia/fear, VR scene designed and outcomes following intervention (functional progress with phobia/fear, and Target Behaviour Ratings).

Child	Presenting phobia/fear	VR scene designed	Outcome following VRE treatment sessions; examples showing outcomes at 6 weeks, 6 months and 12 months	Post treatment Target Behaviour Change Ratings		
				6 weeks	6 months	12 months
A	A had a fear of dogs which occurred every time A saw a dog, whether outside or inside the home. Any time the family were getting ready to leave the house and there was possibility of seeing a dog, A would become anxious.	A street scene with adjacent open land. Dogs of varying sizes appeared in the scene, first on a lead and then running around off lead. The dogs could be made to bark.	At 6 weeks A was described as not having such a big reaction to dogs as previously. A family friend was visiting with a puppy and A said hello to the puppy and stroked the dog. They are going camping with this friend and this puppy will be going. A did not react as much as previously when his cousin's Labrador came to the house. At 12 months after treatment, A had overcome his fear to the extent the family now have a puppy. A has grumbled but has had her on his knee and has stroked her. On the whole he is tolerating the idea. A is described as not as anxious as he was around dogs.	3.0	2.0	2.50
B	B had a fear of dogs. The family lived close to the beach and were unable to go for walks anytime during the winter months when dogs are allowed off lead on the beach.	As above	At 6 weeks, B was able to go to the beach while there were dogs running around. B allowed the dogs to approach. At six months post intervention, B continued to go to the beach and walked calmly past dogs in the street. At 12 months post intervention, the family were able to visit the beach. In some situations with dogs, B is described as still feeling some anxiety but uses the techniques learnt during the study to manage it.	2.25	2.75	2.75
C	C had a fear of being a passenger in a car. C was particularly stressed if the car stopped for any length of time e.g. at traffic lights or in a traffic jam. The longer they are stuck in traffic the more anxious C becomes and it has led to panic attacks.	C was a passenger in a virtual car and they drove through streets and at moments controlled by the psychologist encountered road blockages. The psychologist gradually increased the length of time they were stationary.	At the six week and six month follow up, C's anxieties about travelling in a car remained the same. C has tried the breathing and relaxation techniques and these had some initial impact (6 week vignette rating score of 2.5), but C is described as becoming anxious very quickly in the car and the techniques do not impact on anxiety level. At 12 months follow up, C was still experiencing high levels of anxiety when stuck in traffic or at traffic lights.	2.50	5.0	5.0
D	D was afraid of walking through the entrance doors of secondary school.	Photographs of the entrance to school were taken and reproduced with computer graphics. D practiced 'walking' to the front door and then going through the front door. When the doors opened there were a variety of scenes behind the doors.	After some initial successful approaches to walking through the door to High School, D had to withdraw from the study due to family circumstances.	N/A	N/A	N/A
E	E is afraid of the dark. The fear is worse in the winter when the evenings are dark. E refuses to go upstairs alone and to go anywhere outside the living room without an adult when it is dark. E refuses to go outside in the evening if it is dark.	The scene was a dimly lit corridor with various rooms leading off. E practiced going through doors where it would be light initially and then gradually going into darker areas of rooms.	At the six week and six month follow up, E continues to be afraid of the dark and will not leave the living room if it is dark outside or go upstairs. At 12 months post treatment, E is described as still having a huge fear of the dark and not being able to go anywhere in the house alone. E was however playing out with friends and coming in after dark.	4.0	5.0	3.50
F	F is afraid of making requests, both at school and when on outings. This results in F never asking for help at school or asking for personal needs e.g. going to the toilet. F will remain silent or not make needs known. When out with family, F cannot make age appropriate	The scene was a computer generated replica of their local sports centre that the family visits often. The task was to walk in and ask the receptionist for information and also to order something in the café.	At 6 weeks post intervention, F was able to make requests for items at the sports centre café where they go regularly. This is for the same thing each time e.g. a particular drink. F was not able to make requests at school or after school clubs. At six months post	3.0	4.0	3.50

(continued on next page)

Table 1 (*continued*)

Child	Presenting phobia/fear	VR scene designed	Outcome following VRE treatment sessions; examples showing outcomes at 6 weeks, 6 months and 12 months	Post treatment Target Behaviour Change Ratings		
				6 weeks	6 months	12 months
	requests e.g. asking for something in a café, paying an entrance fee.		intervention, F was able to request different items in a different café, but still on occasion would freeze and say unable to do it. At 12 months post intervention, F could make requests in cafes when prompted and persuaded but is described as still avoiding social interaction when possible.			
G	G has a fear of fire alarms. G spends a lot of time researching all the different types on the internet in order to know the specific noise that each one makes. Every time G goes into a building, G locates the fire alarm and watches it to see if there are any irregularities in the flashing light. This is causing problems at school as G is spending a lot of time watching the fire alarm in the classroom. If G thinks anything may be wrong with a fire alarm, G becomes highly agitated.	Several different scenarios with fire alarms on the wall. G has to spend increasingly long times in the rooms with the fire alarms and built up to hearing the alarm go off.	At 6 weeks post intervention, G was described as no longer afraid of alarms. G can now stay in the classroom when fire alarm tests are done. G is not preoccupied with checking for faults when the family are out which has made things a lot easier. At six months post treatment, G was still much less anxious around fire alarms. During this time they were involved in a fire alarm and evacuation of a supermarket and G took mums hand and walked out calmly and waited calmly outside for the fire brigade to arrive. At 12 months post intervention the improvements had been maintained.	1.25	1.0	1.25
H	H was afraid of thunder and lightning. When there is a storm H will become agitated and will hide under the duvet wrapped in a blanket. H is upset for several hours after a storm.	The scene was a house with glass doors to outside. An increasingly loud storm could be introduced to the scene.	At six weeks post intervention, H was described by the teaching assistant as having no reaction when there was thunder on a school outing. H remained calm that evening when there was thunder at home. At six months post intervention there had been few examples of thunder and lightning. H was able to watch videos of thunder and lightning and manage his anxiety and said did not feel as afraid of it or worry about it happening. At 12 months post intervention, H had experienced summer storms and remained calm throughout.	2.0	2.75	2.25

Target behaviour scoring.
1 = normal; 2 = markedly improved; 3 = definitely improved; 4 = equivocally improved; 5 = no change; 6 = equivocally worse; 7 = definitely worse; 8 = markedly worse; 9 = disastrously worse (e.g., had to be hospitalized).
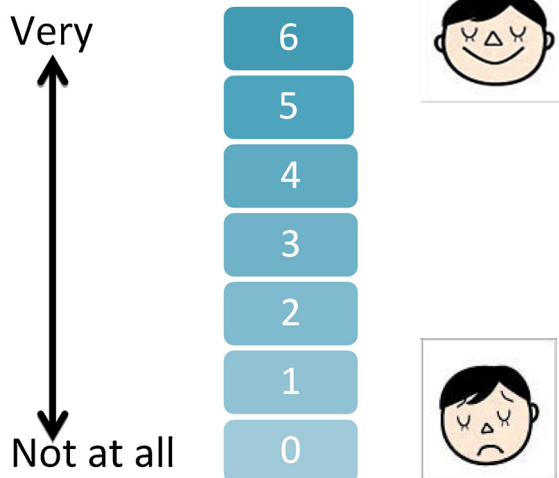
Fig. 1. Child confidence chart.

At a second home visit, the family met the first author and a psychologist who would be working with the child (author 5 or author 6); during this visit a psychoeducation session was carried out. The team discussed with the child and parents the selection of the specific phobia to be addressed in the virtual reality scenes, and the behavioural goal the child wished to achieve. The psychologist (who the child knew would be with them during the VR sessions) explored with the child possible graded steps to full exposure. The psychologist explained the 'safe' nature of the virtual reality sessions, and that reducing or stopping exposure was possible, and under the child's control. Basic cognitive and behavioural therapy techniques were introduced such as identifying feelings (how different parts of the body feel, recognising different thoughts they may have about their phobia), and introducing the concept of a 'feeling thermometer' which is a visual analogue scale used to communicate level of anxiety. As well as establishing which words the child uses to describe their own anxiety symptoms e.g. worried, stressed, tense. During this visit there was training in muscle relaxation, deep breathing, and using positive coping thoughts and statements when experiencing anxiety. The psychologist received guidance and supervision from a consultant clinical psychologist. The consultant clinical psychologist met with the psychologist before and after the home visits to discuss the plan for the intervention and attended day 1 of the intervention.

Following this an individualised scene was prepared by a Third Eye Neurotech programmer, and each participant received four computer-delivered virtual reality exposure sessions lasting approximately 20 minutes each session. The intervention was delivered at a Newcastle University assessment suite, over two half days, approximately one week apart. Two sessions on each half day were separated by a 15 minute break. The child and psychologist sat side by side and the computer monitor was directly in front of them on a table (see Fig. 2 for a photograph of a treatment session) at a consistent distance. The computer monitor had a diagonal screen size of 24 in. with an attached sound bar with stereo speakers. The psychologist operated the graded computer generated scene via an iPad. The research assistant and the parent(s) observed the sessions from an adjacent room, via a one way mirror in the intervention room.

At the beginning of each virtual reality session, a relaxation scene (e.g. swimming dolphins) with soft music was played for several minutes. The psychologist practised breathing and muscle relaxation exercises with the child during this time. When the child felt ready and reported low levels of anxiety on the visual anxiety scale, the psychologist began the target virtual scene.

The target scene began at a level of slight challenge but which was manageable for the child (a situation they had previously rated as eliciting a low anxiety response on the visual anxiety scale). For example, for a child whose goal was going through the front door of a high school, the session would begin with practising approaching the door but stopping at a distance away. This would be repeated several times as required by the child, with the psychologist checking how the child rated their anxiety on the visual anxiety scale, how their body was feeling and what they were thinking. This was an opportunity to make the children aware that they could reduce the anxiety sensations in their body through breathing and muscle relaxation exercises, and that they could challenge the thoughts that occurred in the situation and replace these thoughts with more positive statements. The scene was gradually increased in challenge over the four sessions but with the same checking process by the psychologist at all stages. The psychologist controlled the scene via an iPad; each scene had moving images giving a dynamic feeling within the scene. Parents were able to observe their child's reaction to increasing levels of challenge and how the psychologist supported the child in using CBT techniques during the session. At the end of the final virtual reality session, each family planned with the psychologist how to gradually increase real life exposure to the phobia outside the clinic setting, while working towards the child's goal.

Follow-ups were conducted at 6 weeks, 6 months and 12 months post intervention. The research assistant contacted the parent to repeat anxiety questionnaires and obtain an update on the child's response to the target anxiety situation.

Fig. 2. Child and therapist during a VR session.

2.4. Analysis

Pairs of target behaviour vignettes about the specific phobia/fear were compared for all time points. The mean and standard deviation for the SCAS total scores for the group at each time point were calculated, as well as the scores for each participant at each time point.

3. Results

Table 1 shows each of the eight children's phobia/fear situation, the scene which was designed for them and their pre and post intervention (at 6 weeks, 6 months and 12 months) functional ability in handling the specific phobia/fear situation.

3.1. Target behaviour ratings

Four children (Child A, B, G and H) were classed as responders to the treatment (target behaviour score less than 3) and improved in their functional ability in relation to the phobia. Three children (Child C, E and F) did not respond to the treatment. Child D was not able to carry out follow up measures due to family circumstances, although he did complete four treatment sessions and made some small steps to graded exposure according to feedback given by parents at the point of exiting the study.

3.2. Confidence ratings

Fig. 3a and b show the change in confidence in tackling the goal situation over the course of the sessions, as rated by the children and the parents.

For seven out of eight of the children confidence ratings improved from the beginning of session 1 to end of session 4. One child stayed at the same level of confidence throughout the treatment, although this child was classified as a responder to the treatment.

3.3. Spence children's anxiety scale

The total scores for the SCAS for both the parent and child versions at baseline, 6 weeks, 6 months and 12 months post intervention are presented in Table 2.

For typically developing males aged 8–11 years, a total score above 40 indicates levels of anxiety above the normal range for that age group. For those aged 12–15, a total SCAS score above 33 indicates levels of anxiety above the normal range. No indicative cut-off scores are available specifically for children with ASD. Child C, E and H had elevated levels of anxiety at baseline on both the parent and child questionnaires, as well as child G on the child SCAS. At 12 months after treatment child B, E and H had elevated scores on the parent SCAS and child B, C, E and H on the child SCAS. All the other children scored within the normal range for their age group.

Although the small sample size precludes statistical analysis, of note those children classed as responders (child A, B, G and H) did
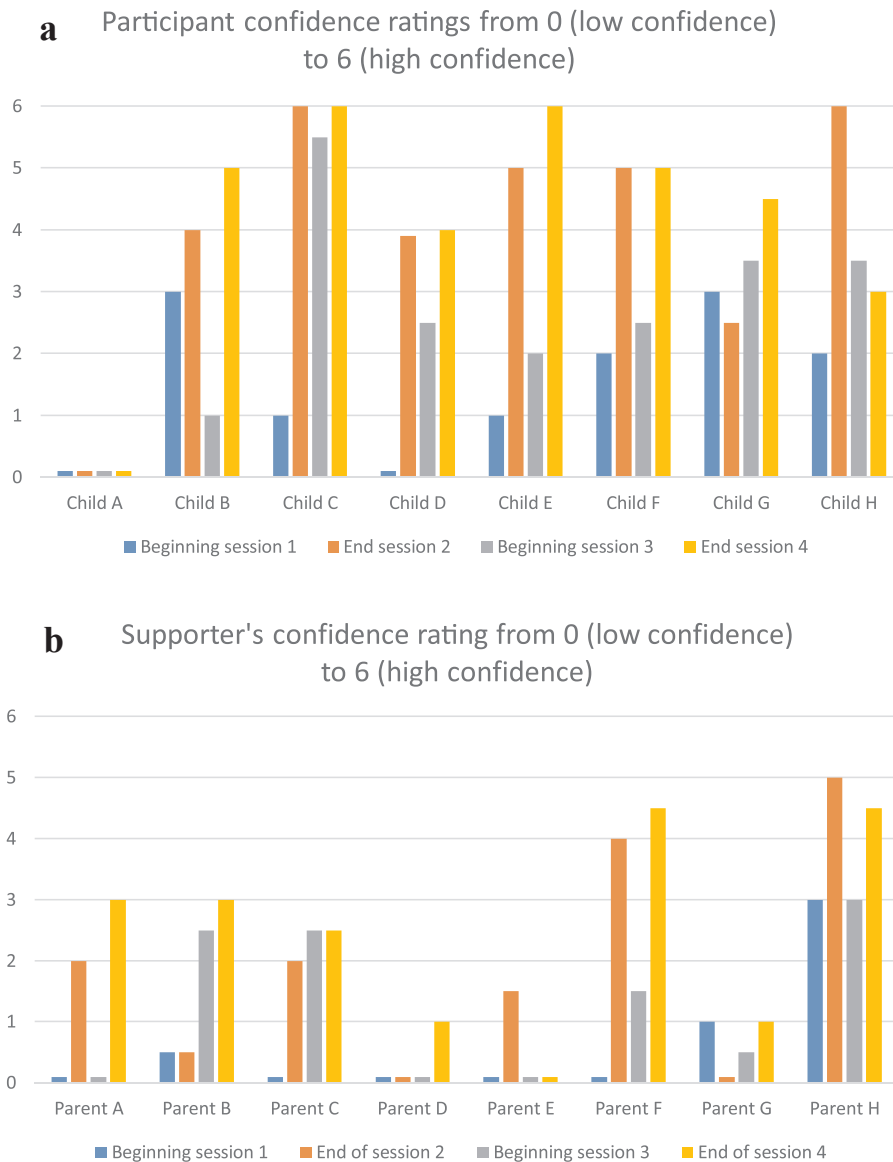
a   Participant confidence ratings from 0 (low confidence) to 6 (high confidence)

b   Supporter's confidence rating from 0 (low confidence) to 6 (high confidence)

Fig. 3. (a) Participant confidence ratings for sessions 1–4. (b) Supporter confidence ratings for sessions.1–4.

show a decrease in self-reported anxiety symptoms, measured with the SCAS at 6 months follow-up, with this reduction maintained for two children (child A and G) at 12 month follow-up. By contrast, none of the children classified as non-responders showed a reduction in self-reported anxiety.

4. Discussion

We aimed to evaluate the feasibility of computer screen delivery of virtual reality images alongside CBT for young people with ASD experiencing specific phobias. We also aimed to explore whether children could potentially benefit from this intervention. In terms of clinical and research feasibility, each child completed four sessions of twenty minutes of graded exposure. One child was lost to follow-up due to family circumstances, although they completed the four intervention sessions and made some small steps to real life exposure before withdrawing from the study. The remaining participants completed the follow-up measures. Regarding potential benefit, four out of the seven children were classed as responders to the treatment. The results show that, for some children, flat screen delivery of individualised virtual reality alongside a psychologist was successful in helping them develop techniques to manage their anxiety in the real world situation. Their improvements were maintained at 12 months post intervention. Data relating to child self-report anxiety symptoms ascertained with the SCAS indicated that those children who were classified as responders also showed a decrease in anxiety symptoms from baseline 6 months post intervention (maintained at twelve months for two children). In

Table 2

Parent and Child reported Spence Children's Anxiety Scale (SCAS) total scores.

	Mean age	SCAS-P				SCAS-C			
		Pre-intervention	Six weeks post intervention	Six months post intervention	12 months post intervention	Pre-intervention	Six weeks post intervention	Six months post intervention	12 months post intervention
Mean whole Sample (n = 8)	9 years	39.0 (15.1)	38.3 (14.8)	41.14 (18.4)	40.14 (19.2)	41.0 (19.9)	31.3 (15.5)	38.0 (16.9)	47.9 (19.3)
Child	Age (years)								
A	12	10	15	7	9	24	15	4	19
B	8	30	37	43	49	39	15	35	44
C	10	58	59	62	39	44	44	44	58
D	11	38	32	–	–	17	26	–	–
E	9	55	55	60	73	51	53	58	80
F	10	37	35	38	34	22	35	38	39
G	11	39	35	34	34	76	–	38	38
H	8	45	–	44	43	55	–	49	57

contrast, none of the children classified as non-responders reported a decrease in anxiety symptomatology. Due to the small sample size it was not possible to undertake inferential analysis ofthese data.

In our previous study which used a totally immersive VRE room for exposure (Maskey et al., 2014) we found that eight out of the nine children who took part were responders to the treatment with four of those children completely overcoming their phobia (target score of 1.0). It is possible that a greater degree of immersion may have greater exposure impact on phobia, but a definitive conclusion would require a larger sample size and comparison study.

Three children in the study were not classed as responders to the treatment on Target behaviour ratings (Child C, E and F). Child C and E had very high total scores on both the self-report and parent reported scores on the SCAS throughout the study, and in comparison with the other participants in the study. It may be that very high initial anxiety levels may moderate the treatment effect. Child F made some progress towards his goal in that he was able to begin making requests with supervision. However, he was unable to generalise this ability to all situations and still would avoid social interaction if possible. In future studies we would aim to investigate the profile of which young people with ASD may benefit from flat screen delivery of virtual images, including their anxiety profile and nature of phobia.

4.1. Limitations and future work

As this study included a small group of young people, future studies should include a larger sample size, and also include children who are being seen clinically within a mental health service. We would also seek to investigate whether more than four treatment sessions might have a greater impact on anxiety reduction for children who did not improve. We will investigate whether flat screen delivery of virtual images may have a role in therapy for adults with ASD experiencing phobias.

In future, larger studies, we will investigate the profile of responders and non-responders to treatment and those for whom flat screen delivery may be effective and appropriate versus those who may need a greater level of immersion. It may be that for some children with ASD, individualised scenes for their phobia delivered by flat screen monitor, supported by a psychologist, may be sufficient whereas for other children it may be necessary to progress to more immersive virtual reality delivery, such as the Blue Room setting.

4.2. Implications

The clinical implications of this study are that a simplified method of delivery of individualised virtual reality treatment can be acceptable for some children with ASD, and can be sufficient to allow reduction of anxiety associated with specific fears and phobias. Flat screen computer-delivered virtual reality means the intervention would be potentially more easily deliverable in a clinical setting than using immersive VRE – although it may not be as effective as immersive VRE for some children. Clinically, adaptations to existing anxiety interventions have been recommended for young people with ASD (NICE, 2013). The intervention we have developed (for both flat screen and fully immersive VRE) contains a number of elements which have been recommended by NICE for adaptations to CBT for young people with ASD and anxiety (NICE, 2013). The intervention includes emotion recognition training in the psychoeducation session, which helps participants learn to recognise their anxiety and its magnitude in differing scenarios. Much of our communication with participants is visual and the need for verbal instructions is lessened due to the visual nature of the VREs. Participants use visual scales to indicate their anxiety levels to the psychologist. In line with the NICE guidelines, parents are also involved in the intervention. They observe the techniques their child is using to manage their anxiety, enabling parents/carers to facilitate the real life graded exposure after the VR sessions. Finally, the VR delivery is often appealing to young people with ASD and

this helps to maintain their attendance and engagement with the process.

Conflicts of interest

Acknowledgements

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