Finding a place to sit: a preliminary investigation into the effectiveness of virtual environments for social skills training for people with autistic spectrum disorders

A Leonard, P Mitchell and S Parsons

School of Psychology, University of Nottingham, University Park, Nottingham, NG7 2RD, UK

anne.leonard@nottingham.ac.uk

http://www.asinteractive.org.uk

ABSTRACT

Seven teenagers with an Autistic Spectrum Disorder (ASD) experienced a Single-User Virtual Environment (VE) of a café, with the learning objective of finding a place to sit in different circumstances. Participants also saw a video of real cafés and buses and were asked to choose where they would sit and why. These measures were taken three times: half of the participants received their VE intervention experience between the first and second videos, and the other half received this experience between the second and third measures. Naïve raters coded explanations according to level of social appropriateness. There was a significant improvement in the appropriateness of social observations in the learning of specific objectives in the same café context. Generalisation of learning to a bus context was more difficult and more spontaneous for some individuals than others. Conversations referring to the social scenario depicted by the VE were a great learning opportunity for the participants. This emphasised the importance of the teacher's use of the technology as a teaching tool rather than technology that will directly teach students. The results positively encourage the idea that VR could be a good learning tool for social skills for people with ASD.

1. INTRODUCTION

1.1 Why Virtual Reality and Autistic Spectrum Disorder?

Autistic Spectrum Disorder (ASD) encompasses Autism and Asperger's Syndrome (Wing, 1996). People who come under this umbrella term have difficulties in three main areas (commonly called the Triad of Impairments): communication, imagination, and social skills. The use of Virtual Reality (VR) has been proposed by some (e.g. Parsons & Mitchell, 2002) as potentially offering a platform to teach social skills to people with ASDs. Users of the technology could be able to practise specific skills in a safe, calm environment which enables rule learning and repetition of tasks. Playing different roles within a Virtual Environment (VE) could be beneficial in perspective-taking of others within a social situation, something that people with ASDs struggle to understand easily (Mitchell, 1997). Many people with ASDs enjoy using computers and related technology, have made significant learning gains using different software packages (e.g. Moore & Calvert, 2000), and might welcome them to study aspects of life that they do not find simple.

1.2 What do we know already about how people with Autism can use VEs?

So far, due to the dearth of previous research on the use of VR with people with ASDs, researchers involved in the AS Interactive project at the University of Nottingham (Parsons et al., 2000) have had to answer more fundamental questions about use and understanding before being able to consider whether this technology is suitable for teaching social skills. The emerging picture has been very positive, showing that use of the technology, including abilities using the joystick, mouse and interactions with the VE were akin to normally developing participants matched by Performance IQ (Parsons et al., submitted). Participants also showed a basic understanding of representations, and mostly understood the difference between a videoed scene of a café and a VR café. All participants who took part in previous studies were very motivated by the use of the technology, and commented that they liked using the programs.

1.3 The present study

This present study aims to build on the encouraging results obtained so far, by investigating learning of a specific social skill within a VE. The social skill under investigation was to know where to sit in a café in relation to where strangers were sitting. To assess social skills before and after VE use in a real café could be problematic, due to not being able to control variables, for example, how busy it was. Therefore, videos of a real café were used as an approximation of real-world judgements, in order to assess any changes in explanations after using the VE. The main hypothesis was that after using the four progressive levels of the VE, there would be a marked improvement in the appropriateness of participants' social judgements of choice of seating within a café context. In addition, the issue of whether participants would generalise judgements to a different scenario was assessed using video clips of buses.

2. METHOD

2.1 Participants

7 participants, 4 males and 3 females, were chosen from a special school in the UK for people with ASDs to take part in this study. All were diagnosed with an ASD, and aged between 14 and 16 years (mean=15:0 years). All showed a full-scale IQ between 65 and 110 (mean = 83.1; assessed by the Wechsler Abbreviated Scale of Intelligence; Wechsler, 1999). The mean verbal score (VIQ) was 81.9 (range 55 to 125) and the mean performance score (PIQ) was 87.1 (range 68 to 107). Participants were divided into two groups, broadly matched in terms of IQ, gender and age. No significant differences were found between the characteristics of the two groups using independent samples t-tests. Parental permission was obtained before commencing the study.

2.2 Design

This study is a mixed design; all participants received the same tasks, but completed them in a different order (see Table 1).

Table 1. *Ordering of tasks in the overall study design*

Group	Time 1		Time 2		Time 3
1	Video measures	Intervention with VR Café	Video measures	–	Video measures & verbal feedback
2	Video measures	–	Video measures	Intervention with VR Café	Video measures & verbal feedback

2.3 Materials

The VEs were built using Superscape VRT and run on a laptop computer or PC using Visualiser software. A joystick and a mouse were used to manoeuvre around the environment and activate objects or initiate interactions within the environment, respectively. The video measures were shown using a combined 14-inch television and video player. All sessions were digitally videotaped for later analysis and transcription, and photos were made through the digital picture capture function. A video with 15 30-second excerpts of cafés and buses in and around Nottingham was created specifically for the video measures.

2.4 Procedure

2.4.1 Use of Virtual Reality Café All students (except one, P3) had used VEs in previous studies (Parsons et al., submitted). These were: a training environment designed to practice use of the joystick and mouse, carrying out procedural tasks in a small café (such as choosing food and drink and paying) and negotiating around avatars in a Café in order to obtain a drink, designed to assess their awareness of personal space in a VE. P3 used the first 2 out of 3 of these VEs before participating in this study.

The VE under investigation consisted of 4 main learning levels with 3 training levels beforehand. The training levels consisted of teaching the participant about how to click areas for different functions (see Table 2). The learning levels were graded in terms of difficulty (Figures 1 & 2), the higher levels with more avatars in different places to make the task more complex and socially demanding (see Table 2).

For the main learning levels, the participant started at the canteen till with food and drink on a tray, and was told that their task was to "Find a place to sit down" from the choice of six tables. The VE program was designed to give visual and verbal feedback that might encourage the participants to learn where was the best

place to sit in different circumstances. There were two main "rules" that were taught: when there is an empty table available in a café, you should sit there rather than sit with strangers; and when there are not any empty tables, you should ask someone "Can I sit down?" or "Is this seat available?" before sitting down. If someone sat down without asking, the person sitting at the table would say "Excuse me, that seat is taken". If the participants chose an inappropriate question, "What is your name?", they were told that this was not connected to their task. All verbal instructions and speech were written in the text box to make it accessible for those who preferred listening or reading. The session was scaffolded by the researcher to reflect participants' individual needs. There were no specific scripted prompts, that is, questioning where appropriate, letting the participant make "mistakes" when it would open up a learning opportunity, and discussing with the participant what the "most polite" course of action would be in different circumstances. There were two VE sessions for each individual, within 7 days of each other. The first session consisted of the training levels 1 to 3, then teaching levels 1 to 4. The second consisted of teaching levels 1 to 4, to remind them of the different rules in the scenarios. Then the participants completed a worksheet in which they completed the sentences "When a café has at least one empty table, you should…" and "When a café has no empty tables, you should…" accompanied by screenshots of the related VE levels.

Figure 1. *Level 1: Empty café*

Figure 2. *Level 4: Busy Cafe*

Table 2. *A description of each level of the Café Virtual Environment*

Level	Set-up	Learning objectives
Training 1-3	Listen to instructions and click on areas in the VE corresponding to different functions.	Learn which areas to click in the VE to perform different actions: ▪ Click on table to sit down ▪ Click on floor to stand up ▪ Click on ear to rehear the current instruction ▪ Click on the question mark to hear the overall task ▪ Click on the speech bubble icon to ask a question ▪ Choose a question and select OK to ask a person 1 of 3 questions
1 see Fig 1.	All six tables are empty, and there is no-one else in the café standing up.	▪ Manoeuvre around the café. ▪ Choose a table to sit down at.
2	2 tables are full, 3 tables have at least one person with some free spaces, and 1 table is empty.	▪ Choose an empty table to sit down at ▪ Understand where it is alright to sit down without asking anyone.
3	3 tables are full, and 3 tables have 1, 2 or 3 people sat at them. There are no empty tables.	▪ Understand where it is necessary /appropriate to talk to people in a café ▪ Understand what is appropriate to say to strangers
4 see Fig 2.	Set-up of tables is exactly the same as level 3. There is background noise of talking and laughing, and some people are walking around the café.	▪ Be able to do all of the above with background noise. ▪ Cope with and manoeuvre around people walking around

2.4.2 Video Measures procedure All participants were asked to watch videoed scenes at three times. Half of the participants experienced the VE intervention between Time 1 and 2 (Group 1), and half experienced it between Time 2 and 3 (Group 2). Five excerpts (see Table 3) lasting approximately 30 seconds each were shown at each time, and three different sets of these. The order that these three sets were shown was counterbalanced across participants.

Table 3. *A description of each excerpt from the video*

Name	Description	Assessment of learning type
Café A	Café: At least one table with no-one sitting at it	Specific learning
Café B	Café: All tables with at least one person sitting at it	Specific learning
Bus A	Bus: At least one empty double seat	Generalising learning between contexts
Bus B	Bus: All double seats with at least one person	Generalising learning between contexts
Bus C	Bus: Bus Driver seat not inhabited	Over-generalisation of learning

The participants were told that they were going to view a short video of some cafes and buses and would be asked some questions about it. For the cafés, they were told: "When you go into this café, you need to sit down to eat your food". For the buses, the participants were told: "When you go onto this bus, you need to sit down to travel". Then after either question, they were asked: "What would you do next?" After providing a description of what they would do (sometimes with further discussion with the researcher), they were asked "Why would you do that?" or "Why would you sit there?" Participants were encouraged to specify exactly where they would sit or stand on the viewed scene by pointing on the television screen, and were digitally videoed during the whole time of the 5 excerpts.

3. RESULTS

3.1 Excluded participant

One participant (P1) had to be excluded from further work after his first VE session. He sat down at tables without asking 8 times in total, and did not change this inappropriate behaviour after the program and the researcher gave feedback. He became frustrated that he was not succeeding in the task, so it was decided by a teacher and the researcher to discontinue his work with the VE. This left 6 participants who took part in the whole study, three in each group.

3.2 The VE sessions

3.2.1 Behaviours shown Most individuals made inappropriate actions only in the first session (Table 4), or not at all (P3, P5, P6, and P7), which included all 3 females (who were higher in their IQs than the males). The two participants who still made errors on the second session (P2 and P4) were not making the errors that were directly tackled with feedback from the VE (i.e. sitting down without asking), but were making additional actions in approaching people in the café to make contact with them, particularly P4, who had behaved in a similar way in the VEs in a past study (Parsons et al., in preparation).

Table 4: *Inappropriate Actions in VE sessions*

Action	Participant	P2		P3		P4		P5		P6		P7	
	Session	1	2	1	2	1	2	1	2	1	2	1	2
Sitting down without asking		-	-	2	-	-	-	1	-	2	-	-	-
Asking an inappropriate question		-	-	-	-	2	2	-	-	-	-	-	-
Returning to someone already asked		-	-	2	-	-	-	-	-	1	-	-	-
Asking someone standing up a question		-	-	-	-	3	1	-	-	-	-	-	-
Full table visit with intention to sit or ask a question		1	3	2	-	-	1	-	-	1	-	-	-

3.2.2 Interactions between facilitator and participant The role of the facilitator (researcher in this case) was important in making sense of the feedback the VE gave when inappropriate actions were made, more so with some participants than others. Table 5 gives an excerpt from a transcription of a conversation between the researcher (R) and the participant (P4) whilst using the VE to illustrate this point.

In the session with P4, the researcher is enabled by the technology to "look around" the café many times, to point at and discuss individuals in particular. It is possible that P4 may not have understood about the rule to sit at an empty table. However, on the worksheet after the second VE session, his completion of the first sentence was "When a café has at least one empty table, *you should go and sit at it"* indicating that he *did* know which table he should sit at, but just wanted to explore the café and the people. P4 made many advances towards talking to people standing up and sitting at full tables in previous studies, which are behaviours that he might not have attempted in ordinary life.

Table 5: *Transcript of interaction between researcher and participant*

VE Session 2, Level 2: Empty table available
P4 goes to tables with people sitting at them rather than sitting on the empty table. R resets level in order to have a discussion about the level
R: *Where would be the best place to sit down? You can't sit on that one, or that one* (pointing to full tables). *There's three tables with some free seats but there's one table with all free seats. Where do you think is the best place to sit?*
(P4 points at a 4-seat table with a couple sitting at it)
R: *Why?*
P4: *Because these people sound friendly*
R: *They sound friendly. But if this was a café and you didn't know anybody…*
P4: *Just ask them if I could sit down there*
R: *Would it not be best to go to the empty table? These two people* (pointing to couple) *might be having a conversation that was quite… private.*
(No response)
R: *Do you think they might just want to chat? Maybe they're on a date and they just want to talk to each other.*
(No response)
R: *Do you think maybe it would be best to go to the empty table?*
P4: *To the red one? No way!*
R: *Why not?*
P4: *I'd be all on my own*
R: *You don't want to be by yourself?*
P4: *No*
R: *But what about these people? They may just want to be by themselves and be quiet. Do you think you might be disturbing them?*
(No response)
Asks "What is your name?" to the table with a couple. He is told "That is not connected to your task. Try something else"
R: *They didn't really like that did they?*
Asks "Can I sit down?" to the table with a couple. He is told "Sorry, someone is sitting there"
R: *I think you should try the empty table as then you wouldn't have to ask anybody would you?*
Asks "Is this seat available?" to the table with a couple. He is told "Sorry, someone is sitting there"
Asks "Is this seat available?" to the table with a man. He is told "Sorry, someone is sitting there"
R: *Why don't you go to the empty table? 'Cause you know no-one's sitting there, don't you?*
Goes to empty table and sits down

3.2 Video judgements

The performance on this task was assessed using the judgements of 10 naïve independent raters (age range 20 to 51 years; mean=29; 1:1 sex ratio), most of whom were students. The 95 excerpts were randomly ordered into a questionnaire format, with the dialogue between the researcher and participant shown and the digital picture of the specific café/bus talked about, with an arrow indicating where the participant had chosen to sit (see Figure 3 for an example). No information was given about participants' background or diagnosis, or the nature of the study.

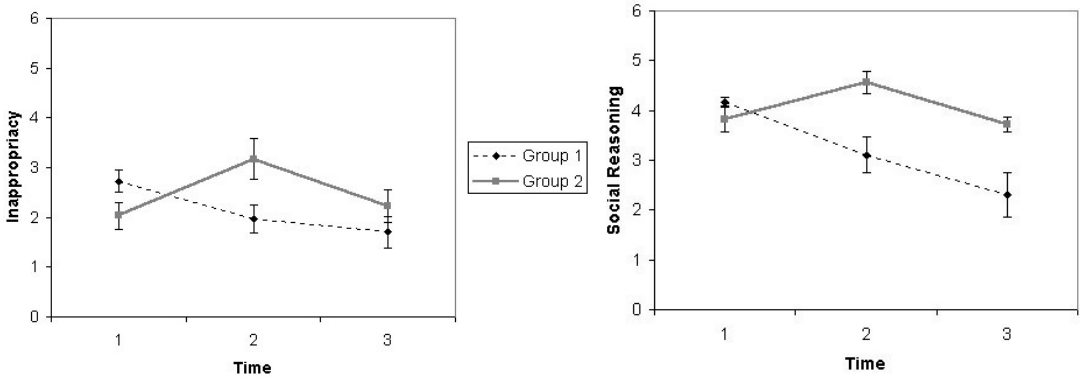
Bus1a
I'd go and sit down.
Where?
[Points to one of double empty seat]
Why would you sit there, at the front?
I like it at the front.

Figure 3. *An example of where a participant would sit in a bus, and the dialogue with the researcher, in the same format as given to the raters.*

Raters were asked to rate this information on two scales in response to two questions. Firstly: "How socially appropriate was their decided action?" This was rated on a 6-point scale from "Ideal" (1) to "Inappropriate" (6). If it was rated inappropriate, they described the nature of this by choosing "Too Polite" or "Rude**".** The second question to raters was "How social was their reasoning or explanation behind the action?" Raters were asked to indicate on a 6-point scale from "Not at all social" (1) to "Very social" (6).

3.2.1 Specific Learning. Gains in understanding were hypothesised to happen only after the different groups' experience with the Café VE. Thus for Group 1, an improvement was expected to happen between Time 1 and 2, yet Group 2 would not improve until Time 3, after they had used the VE. Participants in both groups were able to learn from the two specific learning objectives that were focussed on in the VE sessions, as shown by independent ratings of the video judgements over the three measures.

For the scenario with at least one empty table (Café A), participants were generally rated as showing more ideal behaviour after using the Café VE (Figure 4), as supported by the t-tests showing an improvement between Time 1 and 2 for Group 1 and Time 2 and 3 for Group 2 (Table 6). A repeated measures ANOVA showed that Time was a significant main effect ($F(2,18)=7.5$, $p<0.01$), as was Group ($F(1,9)=12.07$, $p<0.01$) and also the interaction between Time and Group ($F(2,18)=8.541$, $p<0.01$). Initial ratings of this variable were quite low at Time 1, possibly indicating that the students knew what they should do in this situation already. Some students might not have necessarily needed to be taught the learning objective that "You should sit at an empty table if there is one available"; which is why large gains were not made in this variable.



Figures 4 & 5: *Café A, the café with at least one empty table available: Inappropriacy and Social Reasoning mean rating scores for Groups 1 and 2 over the measures at three times.*

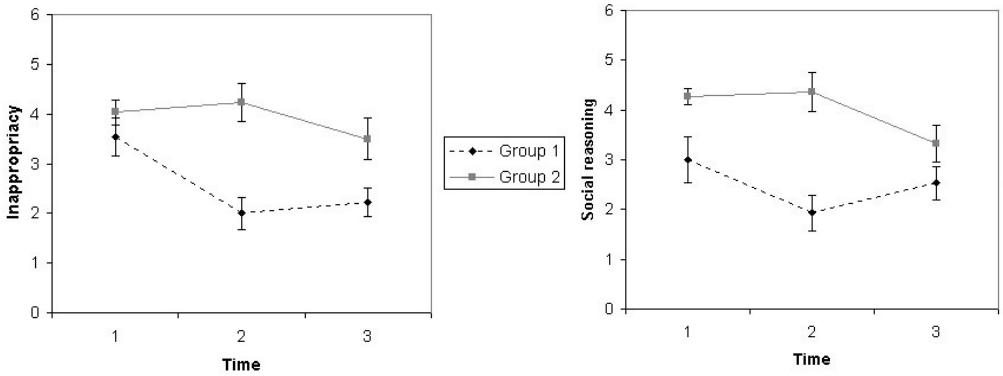
The VE use also made an impact on the social reasoning assessment, also more within Group 1 (see Figure 5), with significant improvements made over the time that they used the VE (Table 6). The ANOVA showed that there was a significant main effect of Time ($F(2,18)=7.5$, $p<0.01$), Group ($F(1,9)=12.07$, $p<0.01$) and an interaction between Time and Group ($F(2,18)=8.541$, $p<0.01$). There were differences at Time 2 between groups, but also at Time 3, indicating that possibly Group 1 were made more aware to the social reasons behind behaviour in a café through the VE sessions than Group 2.

Table 6: *Café A: mean differences and matched pairs T-tests showing differences and improvements.*

Difference	Inappropriacy		Social Reasoning	
	Mean difference	T-test (df=9)	Mean difference	T-test (df=9)
Time 1: Between groups	**0.70**	**3.706****	0.33	1.061
Time 2: Between groups	**-1.20**	**-3.375****	**-1.47**	**-4.047****
Time 3: Between groups	-.53	-1.922	**-1.43**	**-3.204***
Group 1: Difference between Time 1&2	**-0.77**	**-3.083***	**-1.07**	**-2.569***
Group 1: Difference between Time 2&3	-0.27	-0.967	**-0.80**	**-2.882***
Group 2: Difference between Time 1&2	**1.13**	**4.221****	**0.73**	**2.339***
Group 2: Difference between Time 2&3	**-0.93**	**-3.280****	**-0.83**	**-3.049***

***=p<0.05 **=p<0.01**

The perceived inappropriateness of behaviour decreased considerably for both groups over time in relation to use with the VE (Figure 6). There was a significant difference between the groups at time 2 (Table 7), and both groups decreased in the Inappropriacy scale during the time when they used the VE, although not significantly so for Group 2. This is reflected in the repeated measures ANOVA which revealed that Time was a significant main effect ($F(2,18)=5.408$, $p<0.05$), Group however was not ($F(1,9)=4.438$, p=n.s.) but there was a strong interaction between Time and Group ($F(2,18)=11.694$, $p<0.001$). In their post-intervention video measures, all participants were able to say that they should ask people sitting at a table whether the seat was available before sitting down, whereas before the VE use, none of them said they would do this. This observation was independently supported by the judgements of the naïve raters.



Figures 6 & 7 : *Café B, the café scenario with no empty tables available: Inappropriacy and Social Reasoning mean rating scores for Groups 1 and 2 over the measures at three times.*

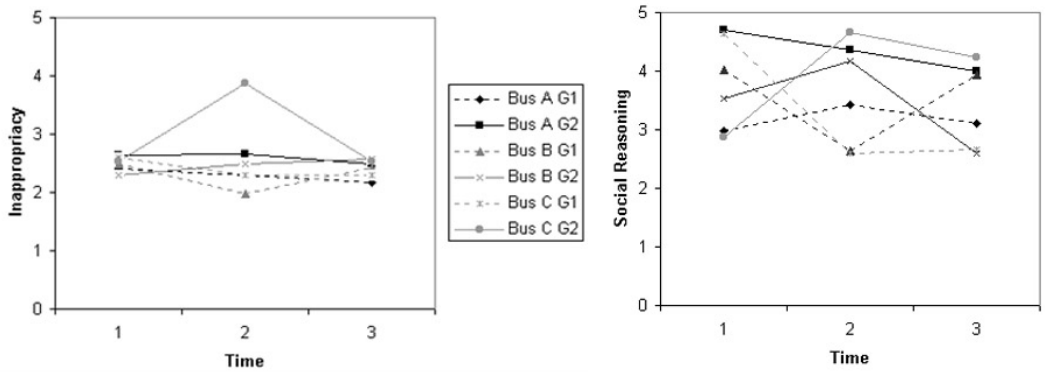
Social Reasoning followed a similar pattern across time (Figure 7), and the groups only improved in this scale during the time that they used the VE (Table 7). The ANOVA revealed that Time was a significant main effect ($F(2,18)=7.203$, $p<0.01$) as was Group ($F(1,9)=28.256$, $p<0.001$), and the Time and Group interaction ($F(2,18)=3.919$, $p<0.05$).

Table 7: *Café B: mean differences and matched pairs T-tests showing differences and improvements.*

Difference	Inappropriacy		Social Reasoning	
	Mean difference	T-test (df=9)	Mean difference	T-test (df=9)
Time 1: Between groups	0.5	1.296	**1.27**	**3.167***
Time 2: Between groups	**2.23**	**5.800*****	**2.43**	**4.245****
Time 3: Between groups	**1.27**	**3.191***	**0.8**	**2.395***
Group 1: Difference between Time 1&2	**-1.53**	**-7.042*****	**-1.07**	**3.403****
Group 1: Difference between Time 2&3	0.23	0.920	0.6	-1.890
Group 2: Difference between Time 1&2	0.2	0.580	0	-.269
Group 2: Difference between Time 2&3	-0.73	-1.754	**-1.03**	**2.514***

***=p<0.05 **=p<0.01 ***=p<0.001**

3.2.2 Generalised and over-generalised learning The participants did not seem to generalise social skills learnt from the café to apply them to the bus scenarios (Figure 8), nor were they made more aware of the social reasons why people sit where they do when they board a bus (Figure 9). The absence of a clear pattern from the graphs shown is supported by the lack of statistically significant differences and interactions. The bus video with the bus driver's seat available was the only variable to show an effect in an ANOVA: the Time and Group interaction being a significant main effect ($F(2,18)=8.2$, $p<0.001$). However, this interaction was possibly due to the anomaly of P6's statement at Time 2 (Group 2; before VE use) that he would sit in the driver's seat, and thus was judged by raters to be inappropriate behaviour. Thus it could be safely concluded that VE learning is specific to that particular scenario and users do not spontaneously apply learning to other similar scenarios.



Figures 8 & 9 : *Buses A, B & C, scenarios corresponding to the cafés and with a bus driver's seat free: Inappropriacy and Social Reasoning mean rating scores for Groups 1 and 2 over the measures at three times.*

4. DISCUSSION

4.1 People with ASDs can use VR technology and can respond to feedback

Most students (all apart from P1) were happily able to learn the appropriate responses through the interactivity with the VE, and did not have difficulty in coping with the negative feedback that an inappropriate behaviour initiated. Their ease of use of the technology was not a surprise considering their previous use of VEs. However, the novel outcome was that they listened to the advice of the researcher and the responses programmed within the VE, and did not continue to make errors which the program was directly tackling. Neale et al. (2002) have extended this knowledge of how VEs can be incorporated into social skills teaching, by investigating how a teacher can use it in variable ways, for example through initiating whole-class discussions over different actions in a VE.

4.2 Social skills learning is carried over to another medium, but not to another context

The video measures over time suggest an improvement in social judgements in most students after using the VE café for cafes with empty tables (A) and without (B). The rated improvement coincided with the timing of the intervention, giving strong evidence that it was the VE use that caused the change in judgements. Given the low inappropriacy rating before VE use, improvements made with Café A were not so noticeable, but Café B judgements improved considerably after VE use, showing that this was something that they needed to learn. Some students did show some crossover between contexts, but generally the learning done in this study was context-specific, although it cannot be determined from this study whether students could generalise to other domains if asked to do so specifically. Awareness of social reasons of why they might do something in a certain situation improved also, showing that it is not just the mechanics that they are learning about social skills in the VE but the reasons behind them also. Further work presently being carried out is looking further into learning within VEs, and whether social skills can be displayed in real-world contexts after training in a VE.

4.3 VE social skills training has unique capabilities in comparison with in-situ teaching

This study has shown the potential for social skills teaching and learning, being a "safe" calm alternative to *in situ* social skills training. The participant is not only greeted with the verbal and visual feedback from the VE, but this is translated and mediated by the encouragement and teaching from the facilitator, who knows the individual and their own learning style, capability and needs. Moreover, VR can essentially have distinctive advantages over "real-world" social skills training, in enabling rich discussions about socially appropriate actions to take place real-time in reference to the avatars in the VE. Conversations with regard to the "people" in the VE can be done openly, yet in a public café, a teacher could not stop in the middle of a café with a student and discuss possible actions and their consequences. VR provides a platform in which social situations can be talked about, which has an element of reality. Future studies might reveal what aspect of the VE lessons are the most influential in learning social skills, for example whether it serves as a platform for discussion, it provides unique feedback in the program or something else. This study indicates the potential for social skills training using VR, and creates a sense of optimism for using this technology with people with ASDs to help them make socially appropriate choices.

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