# SoCueVR: Virtual Reality Game for Social Cue Detection Training

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## ABSTRACT

The ability to recognize social cues and knowing how to approach people in public is an important skill. SoCueVR is a virtual reality game, intended to teach children with autism how to detect social cues and knowing how to initiate contact with strangers. The goal of the game is to support a charity by selling pens to people walking around a mall. Only some of the virtual people are interested in buying and that can be seen in their nonverbal behavior, such as gaze and facial expression. By detecting the nonverbal cues early, the player spends more time selling and less time getting turned down. A prototype was user tested and reviewed by an expert in social training for children with autism, suggesting strong potential.

## CCS CONCEPTS

• **Human-centered computing → Virtual reality**; • **Applied computing → Interactive learning environments**.

## KEYWORDS

virtual humans; social training; autism; virtual reality

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## 1 INTRODUCTION

The lack of certain social skills can make life difficult. An important social skill is the ability to read nonverbal cues, for instance related to initiating contact with strangers. This is a skill required by a number of jobs, such as selling something in public. SoCueVR is a virtual reality (VR) game, intended for children with autism, where they can enjoy practicing particular social skills. The goal of the game is to profit by selling something to strangers walking around a public place. Knowing how to read the nonverbal behavior of the characters and how to approach them is important for succeeding in the game, as the nonverbal cues provide hints about the likelihood of someone buying from you.


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## 2 BACKGROUND

### 2.1 Similar Applications

A number of VR applications teach social skills, such as applications teaching social skills to autistic people [4], training health care professionals in alcohol screening [1], treating social phobia [5] and teaching language and culture skills to military personnel [3]. So far, none have turned the act of initiating contact into a fast paced VR game experience.

### 2.2 Nonverbal Communication

The behavior of the characters in the game is squarely based on existing nonverbal communication research which has also demonstrated the importance of these cues for successful communication. The type of human behavior that is especially important for the goal of the game is behavior that is associated with rapport and behavior indicating whether a person is interested in further interaction with another person.

*Rapport* is an important concept for those who want to establish a relationship with someone. A model of rapport, consisting of attentiveness, positivity and coordination, has been suggested by [6]. The same study suggests smiling, head nodding, forward leaning and direct body orientation are indicators of positivity.

*Avoiding Interaction with Strangers* is a behavior observed in those who do not want to buy from you (potentially wasting your time). Some signals that those people would show have been observed by [2]. These include: Lip compression (lips pressed tightly together and rolled inward), tongue in cheek (tongue pressing against the inside of the cheek so that the cheek is bulging out), and gaze avoidance.

## 3 APPROACH AND IMPLEMENTATION

The implemented game is a virtual mall with characters walking around. The player, wearing a HTC Vive VR headset, tries to sell pens to the characters by looking at them and initiating contact by saying "Excuse me!". The trick is to speak only to those likely to buy from you, i.e. those that react positively to you looking at them. Players try to sell as much as they can within a 2 minute time limit.

### 3.1 Model

When the player tries to sell to a character, the character shows different nonverbal behavior, based on whether it is a buyer or a non-buyer. The state machine in figure 1 depicts the high level states that the characters can be in.

All characters are initially in the *Walking* state, and in that state they wander around the mall. If the player and a character look at

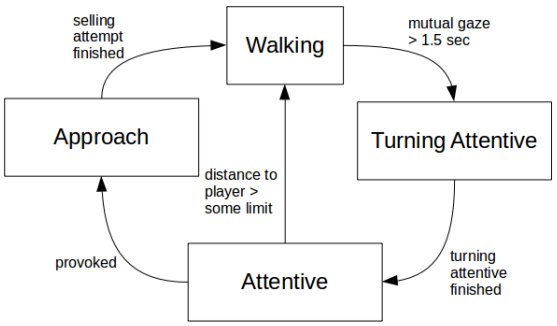


**Figure 1: High level state machine representing the behavior of the characters. Each state can last for some time and certain behavior happens in each state. The *provoked* event occurs when the player speaks while looking at the character.**

each other for more than 1.5 seconds, the character will go into the *Turning Attentive* state and start to show these nonverbal signals:

- Buyers smile while non-buyers show a compressed lips expression.
- Non-buyers only rotate eyes to look at player, but buyers will rotate their bodies more towards them as well.

This nonverbal behavior will persist into the *Attentive* state, where the player can initiate contact by speaking while looking at the character. It is only possible to initiate contact with the characters when they are in this state. If contact is initiated, a character will go into the *Approach* state and walk towards the player to stand in front of them until a sales attempt is finished (shown as a progress bar), resulting either in success (money) or failure (lost time). Buyers will nod during the *Approach* state. If a character is in the *Attentive* state and the distance to the player exceeds a certain limit, the character will go back into the *Walking* state.

### 3.2 Interface

Figure 2 shows a screen from the game. When the player speaks, the sound is picked up by the microphone in the headset. The characters do not understand the speech but they sense if the recorded sound exceeds a certain threshold. A white panel is shown in front of the player with some info on it. The cross hair shows where the player is looking and there is an arrow above the character the player is currently looking at. The appearance of the arrow changes depending on the state of the character.

### 3.3 Implementation

The game was implemented in *Unity*, using characters with *blend shapes*. A special navigation system was created which casts multiple rays from each character, allowing them to sense the shape of the environment in front of them. The characters move in the direction of free space, except when they deliberately approach the player. Special *Choreographer* classes handle character animation. Current Choreographers include: *HumanLocomotion* (for controlling walking animation based on the speed of a character), *HumanGaze* (for controlling where a character is looking), *HumanHead* (for head


**Figure 2: The player is in the process of selling to this woman. On the lower left, the sound volume picked up by the microphone is shown. On the lower right the money earned is shown. While selling, a progress bar appears.**

movements such as nodding), *EyeBlinker* (makes a character blink eyes at random times). For controlling higher level behavior, *finite state machine* are used, where each state activates a *behavior tree* for real-time action selection.

## 4 RESULTS

### 4.1 General Usability

To get a general sense for how well the game works and to identify basic usability problems, an initial usability test was conducted with 12 non-autistic users recruited at the university. The age of the users ranged from 23 to 43, half of them female. All were frequent users of computes and most had already experienced VR. Users were asked to play two game rounds, but were not required to. Only one user chose not to play a second round. After playing the game, each user answered five Likert Scale questions about the experience. They could also write open ended comments on any strengths and weaknesses of the game.

The results from the questionnaire are shown in Figure 3. One of the most definitive results is that users could generally see from the behavior of the characters, whether they would buy from them or not. This was a fundamental assumption for the game-play and therefore important to get validated. Users generally knew what to do and had no problems playing the game. Some, but not everyone, enjoyed the game, and most of them believe that it could help those with impaired social cue perception to improve their social skills.

From the free form comments, two particular strengths and two weaknesses stand out, as they were mentioned several times. The main strength reported by the testers is that the experience felt immersive and realistic. Two users mentioned that being able to use voice contributed to this in particular. The second strength mentioned by several testers was how straight-forward it was to read into the behavior of the characters. The smile was considered to be especially easy to recognize.

One of the main weaknesses mentioned, was that the players felt the urge to walk towards the people in the mall, beyond what the

| (-2=strongly disagree, -1=disagree, 0=neutral, +1=agree, +2=strongly agree) | -2 | -1 | 0 | +1 | +2 |
|---|---|---|---|---|---|
| **Q1:** It was clear in the virtual environment what actions could be taken by me | 0 | 0 | 3 | **6** | 3 |
| **Q2:** The behavior of the characters felt natural | 1 | 1 | 4 | **5** | 1 |
| **Q3:** It was clear from the behavior of the characters which ones were ready to buy from me and which ones were not | 0 | 1 | 0 | 3 | **8** |
| **Q4:** The game was enjoyable | 0 | 1 | **4** | **4** | 3 |
| **Q5:** I believe this game could help those with impaired social cue perception (e.g. having difficulty reading facial expressions) improve their social skills | 0 | 1 | 0 | **7** | 4 |

**Figure 3: Results from usability testing with 12 users who marked on a 5 point Likert scale to what extent they agreed with five different statements (Q1 - Q5) about the game after they played it. The numbers to the right of each statement show how many users picked each agreement level. The most frequently picked values have been shaded. Overall, users tended to agree with the statements.**

3m x 3m room-scale VR setup could accommodate. They basically felt constrained by having to wait for people passing close by before they could approach them. This led to the sense that perhaps some potential buyers were not even coming their way. This could be addressed with a careful redesign of the virtual environment.

The other weakness mentioned by a couple of users, was that they felt that showing only two distinct facial expressions was rather simplistic. However, this limitation was there by design, and comments from a domain expert (see below), mitigate this concern somewhat. However, it might be a good idea to create more than one version of each basic expression, to introduce more natural variety.

### 4.2 Domain Expert Review

In order to evaluate the suitability of the game for children with autism and its potential to teach them social skills, an independent domain expert was brought in to test the game and give an in-depth review. The expert is a psychologist at the national Centre for Child Development and Behaviour, and a regular teacher at their social skill training workshop for 10 - 12 year old children with autism.

Overall, the expert expressed great satisfaction with the game, stating that he would consider using it in its current form, alongside other material in their workshop. He claimed that being able to simulate contact with strangers was extremely valuable, since that is something very hard, if not impossible, to set up during their training program. The game would therefore complement their current training activities very well. He felt the game provided just the right level of realism, not too simple and not too complex. He claimed the environment would work well for most of his students, as it did not provide too many distractions from the task, since storefronts and other busy spots are not really visible. He cautioned that the music between games might need to be softer.

The expert also mentioned he would like to be able to configure several things in the game, to tailor its difficulty level to individual students. Here are some of the things he would like to control:

- How exaggerated all facial expressions are.
- Whether the positive/negative expressions are always visible (not just after you make eye contact).
- How many people are in the mall (density), possibly providing a level with a single person approaching you.

## 5 CONCLUSIONS

The VR game presented here, requires its players to make eye contact with strangers and then correctly read the resulting social reaction. If the player determines that the stranger is interested in what the player might have to say, the player has to speak up before the stranger passes by, and the opportunity to sell is lost. This all happens in real-time and at full physical scale.

The game is able to turn a crucial moment of social negotiation into an enjoyable and engaging game-play element. While general user testing confirmed a relatively smooth ride, it is the feedback from the social training expert that provides the strongest case for a successful prototype. The next step is to work with the national Centre for Child Development and Behaviour on getting the game tested with the intended target group in their social skill training program.

## ACKNOWLEDGMENTS

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