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# Investigating the Non-Verbal Behavior Features of Bullying for the Development of an Automatic Recognition System in Social Virtual Reality

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# Investigating the Non-verbal Behavior Features of Bullying for the Development of an Automatic Recognition System in Social Virtual Reality

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## ABSTRACT

We look at the possibilities of automatically detecting social discomfort and social anxiety via non-verbal behaviours in social Virtual Reality (VR). This is important because a well-developed automatic recognition system could facilitate interventions and moderation in social VR without requiring real-time parental supervision. To initially explore this question of recognition, we prototyped a small set of 3D stimuli representing a bullying scenario and explored in a small formative preliminary study what human observers perceived from the stimuli. Future work is required with different problematic situations in social VR and evaluations with more participants before developing an automatic recognition system.

## CCS CONCEPTS

• **Human-centered computing** → *Human computer interaction (HCI)*; *Collaborative and social computing*.

## KEYWORDS

non-verbal behaviors, bullying, social virtual reality, automatic analyses of human behavior

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## 1 INTRODUCTION

In today's digital world of near-ubiquitous connectivity and increasing use of devices and the digital escape of the "Metaverse" [17], people's interaction, especially that of children and adolescents, is changing [13, 14]. Social Virtual Reality (VR) raises concerns about unsupervised children's interaction with friends and potentially others around the world using headsets [15]. Users can connect via an avatar using their body, moving from 2D to 3D, with the feeling of "being there" [3]. They can also inflict virtual harm on others [10]. As VR is experienced through a headset, it is difficult for parents to observe and understand clearly what is happening and be aware of the misuses and abuses of the technology [13]. Little to no regulations are in place in the virtual environments which have been increasingly attracting children and teenagers [14]. While headset tracking technology is allowing more realistic social interactions of non-verbal behaviors such as eye-tracking, facial and mouth tracking, gesture and voice, little is known about non-verbal behaviors in situations such as bullying, social discomfort and social anxiety. As an initial step, we considered social anxiety and social discomfort in a one-off bullying situation. We crafted 3D stimuli with two virtual characters, limited to stereotyped non-verbal behaviors based on the literature.

The ultimate goal is to address the following research questions:

RQ 1: What factors form the subjectivity sense of being bullied?
RQ 2: Can we use these factors to build an automatic recognition system?

In this ongoing project, we attempted to address our first research question with a preliminary study and seven observers.

## 2 RELATED WORK

### 2.1 Proxemics in virtual environments

Studies have looked at proxemics, the study of interpersonal space between individuals, in virtual environments [12, 21]. Trajectory and interpersonal distances in shared space play an integral role in non-verbal communication and define the types of social interactions [12]. Proxemics theory [7] holds that each individual has their own radius of personal space in a shared space with another individual. The smaller the radius, the more the interaction becomes intimate. There are many factors, such as age, culture environmental context, relationship and emotional state of individuals, that affect proximal relationship between people [21]. We must turn beyond proxemics alone, then, to consider other behaviors.

### 2.2 Non-verbal communication in social virtual reality

Non-verbal cues are crucial in face-to-face social interactions as they convey internal mental states, sometimes unconscious, into physical behaviors. In social VR, non-verbal communication is increasingly used; in particular, facial behavior, gaze, proximity (spatial behavior) and kinetics (gestural behavior) [13]. Increasingly realistic 3D avatars allow full embodiment and seem to lead to deeper connections and social interactions. While this may enable more effective verbal disclosure, non-verbal disclosure, emotion recognition and co-presence, it may also lead to negative situations [2].


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A study reported that participants use non-verbal communication to protect themselves [15]. For example, a participant mentioned the “talking to hand” gesture to combat unwanted interactions. A harasser could also say that their behaviour is just a bug or tracking error in the system [15]. If we are able to identify the combination of non-verbal behavioral features that are classified into harassment or bullying then we could detect these misuses and abuses.

### 2.3 Non-verbal Cues in Social Anxiety, Personality and Dominance

While studies have been interested in bystanders and third-party roles in bullying [9, 16, 20], non-verbal behaviors of bullying have been unexplored. Nevertheless, researchers have been investigating non-verbal behaviors in social anxiety in real-world situations. In particular, a study showed that *"the severity of social anxiety was positively correlated with the self-directed perception of other individuals' gaze, especially when the "lookers" had a negative facial expression"* [19]. This result is disputed by a recent study showing that the context should be taken into consideration and that social anxiety is measured more accurately with heart rate [18]. Dominance and personality traits based on non-verbal behaviors have been researched. It was demonstrated that posture and body language combined with verbal cues could predict the personality of individuals as extroverted or introverted but this would also depend on consistency of the cues [8]. Furthermore, examining dominance-submissiveness non-verbal strategies, researchers have reported "physical potency" (signals of threat, stares, motion, height, weight) and "resource control" (space, precedence, possession) [4].

## 3 METHODS

We developed two virtual characters using the same character base [11] and created animations that mimic a short non-verbal bullying situation that could occur in social VR. We then evaluated the situation via a questionnaire. Software used included: Character Creator 3 [1, 11] and the Virtual Human Project in Unity [6]. A pilot test was conducted with seven participants, three males, three females and one unknown, of age between 22 and 37 years old. After showing each animation in order, two questions were asked: "What do you think is happening?" and "How are you feeling from the perspective shown?". Animations can be viewed: link [5].

## 4 RESULTS

We collected the answers and observed their evolution. After viewing all animations, participants evaluated from 1 to 5 the extent to which character 1 (victim) exhibits social anxiety (Mean = 3.71, SD = 0.95) and character 2 (bully) induces social discomfort to the viewer (Mean = 4.71, SD = 0.49). Looking at results for question 1 (What do you think is happening?). **Animation 1. (Above view)** Answers were neutral, describing the main interaction of a character circling around another one. Some participants did not truly understand what was happening: P5 thought the character was walking around the other and P3 thought the character in the center was timing the laps of the one running around. **Animation 2. (Frontal far view)** As the perspective changed, answers started to be more precise: P1 mentioned someone was "racing" instead of "running", P5 also mentioned "running" instead of "walking", P6 noted the character is running "too close" to the other. P7 was still not sure what was happening. **Animation 3. (Close view with laugh)** Terms like "bullying, "mocking", "mean" and "annoying" appeared at this stage of the evaluation. **Animation 4. (Victim's perspective)** Six participants understood it was the perspective from the victim's eyes, being circled by the bully. P7 was still not sure about the situation occurring. **Animation 5. (Bully's perspective)** Five participants understood it was the bully's eyes. However, P3 answered that someone was having a psychotic episode and P7 was not sure.

Looking at results for question 2 (How are you feeling from the perspective shown?). **Animation 1.** Terms like "indifferent" appeared twice but participants were not certain how to answer. **Animation 2.** P1 and P5 felt "displeased" and noticed the person standing in the center looked "uncomfortable" or "not happy". P2, P3 and P7 mentioned this perspective did not clarify the situation. P4 felt "nervous for the person in the middle". **Animation 3.** Feelings like "sad", "uncomfortable" were noted and three participants mentioned that the bullying situation is clearer. **Animation 4.** Adjectives participants used included "intimidated" (P1), "disoriented" (P3), "stressed" (P4), "weird" (P5) and "annoying" (P7). **Animation 5.** Terms used included "dominant" (P1), "strange" (P3), "weird" (P5), "compassion for the terrorized character" (P6) and "annoying dizzying" (P7).

## 5 DISCUSSION

We can clearly observe the viewer's progression of the understanding and feelings of the situation occurring from animation 1 to animation 5. We can attempt to answer our first research questions: RQ 1. The results provide initial insight into the data required for eventually building automatic recognition systems. It would be the combination of non-verbal behaviors (proxemics, facial expression, gaze and sound) that can lead to subjective senses of the bullying situation. RQ 2. We may be able to use those results to build an automatic recognition system. However, there are limitations to consider and future work before confirming these answers. The number of participants for the pilot test was limited. Gaze patterns and proxemics vary across cultures and differ depending on the context. We only looked at one specific case of bullying and developed animations based on stereotypes. Some facial expressions and gestures may not be apparent in other bullying situations. The non-verbal features can be combined with verbal recognition and physiological measurements such as heart rate. Questions used to evaluate animations may also need modification to collect quantifiable data and better evaluate the extent to which non-verbal features lead to less variations and enable to detect that a negative situation is occurring. Privacy would also have to be considered.

## 6 CONCLUSION

We were able to create a bullying scenario from different perspectives with a combination of non-verbal cues and explored in a preliminary study what human observers perceived. The question remains as to whether the responses obtained are significant enough to give a valid interpretation that can lead to developing an automatic recognition system. Further research is required with a higher number of more diverse participants and more varied situations (of bullying, harassment etc.) that may occur in social VR.

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