Asch conformity experiment using immersive virtual reality

Christos Kyrlitsias
GET Lab
Cyprus University of Technology
c.kyrlitsias@gmail.com

Despina Michael
GET Lab
Cyprus University of Technology
despina.michael@cut.ac.cy

Abstract

Virtual Reality is used in fields of cognitive sciences to study participants reactions. In such cases, existence of other avatars in the virtual environment is a crucial factor. The use of agents, controlled by algorithms, or the use of avatars, controlled by real people, may be a key difference in the results of such studies. Despite the fact that avatars controlled by real people may replicate humans behavior in a more perceiving manner, making VR, by using avatars, a suitable tool to perform such studies, the use of agents facilitate things towards making VR studies needing less human resources to be performed. In this study we investigate whether agents have social influence on the participants by performing the Asch conformity experiment (1951) in an immersive virtual environment. Findings are demonstrating that participants response times were affected by the judgments of agents existing in the virtual environment.

Keywords: virtual reality, computer agents, social influence

1 Introduction

Virtual Reality has been exploited in various ways in aspects related to psychology and cognitive sciences for investigating humans behavior. Blascovich et al. [1] believe that social psychologists can overcome methodological problems such as the experimental control-mundane realism trade-off, the lack of replication and non-representative samples by adopting immersive virtual environment technologies as a research tool. Moreover, according to Wilson & Soranzo [2], Virtual Reality is compelling due to the almost limitless possibilities for the creation of stimuli and this has led to the spread of VR into domains of psychology.

1.1 Humanoid Representations

Humanoid representations in VR are classified into avatars and agents depending on who directs their behavior. Avatar is a digital representation whose behaviors reflect those executed by a specific human being. On the other hand, agent is a digital representation whose behaviors are determined by a computational algorithm [3] [4].
However, as also Bailenson & Blascovich mentioned, the distinction between avatars and agents is not clear. This is due to the inability of today's technology to accurately reflect all human actions on avatars. As a result, an avatar usually constitutes a hybrid of an embodied agent and an avatar [3].

1.2 Social Interactions within Virtual Environments

Exploitation of VR in psychology assumes that a human being perceives and reacts, in our case to social cues in a virtual world as in the physical world. According to the Threshold Model of Social Influence [4] [5], a human in a virtual environment reacts socially only to other people which, as mentioned above, called avatars. The

extent of belief of the user that other human representations represent real people is mentioned as social presence. An agent cannot cause social reactions to humans, unless his behavior is very realistic. The degree to which human representations behave as they would in the real world mentioned to as behavioral realism. The elicitation of social influence in a virtual world depends on these two factors, social presence and behavioral realism.

A study by von der Putten et al. [4] evaluates social presence and behavioral realism, and what impact these two factors have on the appearance of social effects between human and agent. The results showed that whether the participant believes that interacted with an avatar or an agent, did not affect his social behaviour. However, the level of behavioral realism affects participants social behaviour. The results of a study of Guadagno et al. [6], showed differences in social evaluation of participants for a peer counsellor with low social presence (agent) with those with high social presence (avatar). This result supports Blascovich and colleagues model of social influence.

Hoyt, Blascovich, and Swinth [7] demonstrated classic effects of social inhibition when participants were asked to perform a non-trained task in front of an avatar compared to an agent. Conversely, they did not find effects of social facilitation when participants performed well-trained tasks in front of an avatar.

A study replicated Milgrams [8] experiment within a virtual environment. The target for shocks was a virtual human rather than a real person, administered by real-world participants. The results showed that, even though participants were aware that the individual they were shocking was not real, similar findings of increased anxiety and discomfort were recorded among participants.

1.3 Social Conformity

Among the most famous psychology experiments is the Asch conformity experiments [9] [10]. Conformity is the act of matching attitudes, beliefs, and behaviors to group norms. Norms are implicit, unsaid rules, shared by a group of individuals, which guide their interactions with others. This tendency to conform occurs in small groups and/or society as a whole, and may result from subtle unconscious influences, or direct and overt social pressure.

In the original study, Solomon Asch [10] conducted an experiment to investigate the extent to which the social pressure of the majority can influence the person making him to comply. Participants were placed in a room along with seven confederates and were asked to answer some simple line length comparison test. The confederates had agreed in advance what their responses would be when presented with the line task. The real participant was led to believe that the other six were also real participants for the experiment and not that they were part of the experiments scenario as they indeed were. Results, demonstrated that the participants were affected by the pressure of the majority of others. Approximately, one-third of all estimates in the critical group were distorted in the direction of the majority.

A recent study replicates Asch's experiment in Second Life [11], a virtual world application that enables users to create virtual representations of themselves and interact with other users. Participants were given a series of perceptual judgment trials, in which they chose one of three stimulus alternatives that matched the length of a target stimulus. Participants were tested either alone or with three other confederate human avatars whose choices were predetermined by the experimenter. On two of the trials, before the actual participant made their choice, confederate avatars unanimously chose the incorrect answer. Results showed that on these trials participants were significantly more likely to choose in accord with the confederates choices, relative to participants tested as single avatars.

In our study, we used a similar procedure to Asch original experiment, in an immersive virtual environment to investigate the extent to which social pressure from a group of agents could affect a person to conform.

Our experiment differs from Rayburn-Reeves et al. [11] as the participants were immersed in the virtual environment with the use of virtual reality technology. The participants' isolation from the physical world combined with the stereoscopic projection and head tracking, strengthens presence; i.e. the feeling of being in that virtual place. We speculated that this feeling will posi-

tively contribute to the existence of social influence towards the participant.
The second key difference between the two studies is who controls the confederates. In our study, human representations, and their opinion which comes into conflict with that of participant, do not represent real people. That is, in our case we use agents for the confederates and not avatars controlled by real people. According to the Threshold Model of Social Influence [4] [5], when the user believes that the virtual person is controlled by the computer, his feeling of social presence for the virtual human will be low and this is a crucial factor which in this case prevents the occurrence of social influence in the virtual environment.
Moreover, in our study the experimental slide of the visual test remains visible for participants, during the response period, making the task easier than in Rayburn-Reeves et al. study. The difficulty of the task is a factor affecting the results of social pressure [12].

2 Experiment

2.1 Experimental Design

We designed a VR version of the Asch experiment with a between group experimental design. Each participant was either assigned to the control group, in which case the participants avatar was in the virtual room alone (Figure 2, top), or to the experimental group where the participants avatar was in the virtual room with five other agents (Figure 2, bottom). The participant was observing the virtual environment from a first person perspective of his/her virtual avatar. Each participant was experiencing one session of Asch experiment, each session with 12 trials in total (Figure 3). Each trial was a simple visual test with lines length comparison. The trial cards with the lines appear in two boards in the virtual environment.

In the experimental group, the participant and the five agents were answering in turn to all trials. Participants avatar is sitting in the end of the row, thus his/her turn was arriving after he/she was listening the answers of the five confederates-agents. The five agents were giving a wrong answer on 8 of the 12 trials while in the rest trials they were giving the correct answer (Table 1). The visual test of each trial is predefined and the trials appear in the same order in all sessions. The answers of agents are also predefined and always unanimous.

Figure 1: Participants were fitted with an HMD device for stereo display and head tracking and with headphones for stereo sound.

To make clear to the participant, when his turn to give an answer arrives, a label with a number on it, was placed in front of each virtual avatar (participants avatar and agents avatars). The numbers on the labels were indicating the order in which the participants of the Ash test (i.e. the participant of the experiment and agents) should give their answer. To make the order even more clear, in front of all six avatars, a lamp was placed. The lamp in front of each avatar was lit at the time when his turn arrived to give his answer.

2.2 Human Representations

The five confederates are represented by human-like agent avatars, two male and three female. Each agent-avatar has two animation clips. The first clip was played repeatedly. It included small movements that were giving a feeling of liveliness to the characters. The second animation clip was playing while agent avatar was saying his/her answers. The voices used for agents had been previously recorded by three women and two men.
User-avatar selected in advance by the experimenter for each session, between a male and a female character, depending on the gender of

Figure 2: The virtual environment experienced by the participants in the control group (top) and in the experimental group (bottom).

the participant. User-avatars are not animated. However the movement of participants' head is tracked, by the tracker integrated in the HMD device, and they are mapped to the virtual camera. In this way the participant, by moving his/her head arround can observe and explore the environment, his/her virtual body and the virtual confederates.
In the control condition the setup, the process and the trials, were identical to the experimental condition besides the fact that there were no agents in the virtual room. Participants' answers as well as the time it took them to respond in each trial were recorded in both groups.

2.3 Technical Setup

The experiment was performed using a PC equipped with an NVidia GeForce GTX 770 graphics card. The setup includes Oculus Rift DK2 HMD for 3D immersive viewing and head tracking. The application created using Unity 3D game engine, the environment using Autodesk Maya and Adobe Photoshop. Virtual characters designed and rigged using Autodesk Character Generator.

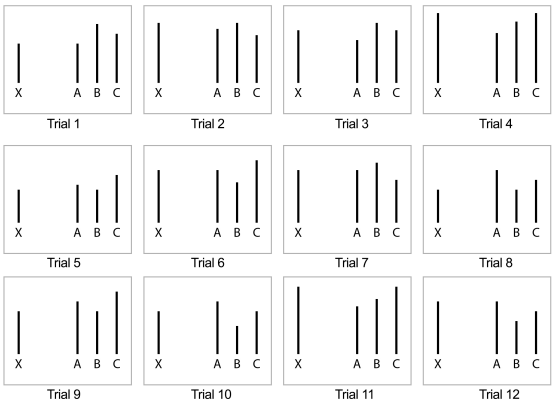

Figure 3: Each participant was participating in a session with 12 trials of visual tests.

2.4 Procedure

The participants, after receiving some general information about the experiment, signed a consent form. Then, they completed a pre-test questionnaire which indicated some demographics, virtual environments/computer games literacy and whether they suffer from a vision problem. Then, they were informed about the process with written instructions. After the Oculus Rift HMD and the headphones were fitted on each participant (Figure 1), the experimenter started the application.
The participant was observing the virtual environment from a first person perspective of his avatar, sitting in front of a desk in a virtual classroom. In case of the experimental group the participants avatar was sitting next to the five agent-avatars (confederates) while in case of the control group no other avatar besides the participants avatar was in the room. Thanks to Oculus Rift head tracking functionality, participants were able to visually explore the environment, the virtual room, their avatars body and the avatars of the agents; the latter only in case of the experimental group. The participants were asked to do so for one minute.

After the familiarization phase elapsed, the first trial appeared on the boards and the agents began to respond in turn. Agents were programmed to answer three seconds after the previous agent completed his answer. The participants had no evidence about whether the confederates are controlled by real people or not. Once the real participant stated his estimate for the vi-

Table 1: Visual tests trial number with the correct answers and answers given by the agents.

Trial Number	Correct Answer	Agents' Answer
1	A	A
2	B	B
3	C	A*
4	C	C
5	B	C*
6	A	B*
7	A	B*
8	B	C*
9	B	A*
10	C	B*
11	C	C
12	A	C*

sual test of the current trial, the researcher noted his answer and the process continued with the next trial. Agents responded correctly in four of the trials (trial 1, 2, 4, 11). In the remaining 8 their answers were wrong (Table 1).
After the completion of all trials, the HMD and the headphones were taken out of the participant and the participant was asked to complete a post-test questionnaire. This questionnaire included twelve 5-point Likert style questions related to participants' subjective experience of immersion within the virtual environment, ownership over the avatar, social presence and the confidence with which they reply to the visual tests (Table 2).

2.5 Data Collection

The experimental data consisted of the participants answers at each trial which were recorded by the experimenter, the Response Time for each trial and the pre- and post-test questionnaires. The Response Time is the time elapsed from the time participants turn arrived, indicated by the lit of the virtual lamp in front of his virtual avatar, until the real participant was giving his answer. The system was programmed to automatically record in a text file the Response Time for all cases.

Table 2: The questions of the post-test questionnaire.

No.	Question
1	The instructions of the study were not clear.
2	The design process was understood.
3	I felt that I was in the place / environment that I saw.
4	I felt that the body I saw when I looked down it was mine.
5*	I had the feeling that the other participants in the test were real people.
6	The answers I gave in the test were correct.
7	The trials were difficult.
8	I have doubts about the correctness of the answers I gave.
9*	The answers given by the other participants(confederates)affected my own answers.
10*	The answers I gave were mainly based on my own opinion.
11	I felt confident about my answers.
12	The body I saw when I looked down I belonged to someone else.
*Questions given only to participants in the experimental group.	

2.6 Participants

In total 22 participants, between 20 and 42 years old volunteers, took part in the experiment; 8 were female and 14 were male. The median age was 24 years. 13 of the 22 participants were placed in the experimental group (7 females, 6 males). The other 9 participants were placed in the control group (7 females, 2 males).
An important prerequisite for participation in the study was the ignorance of the Asch experiment.

3 Results

We firstly consider the questionnaires used to assess the participants feeling of owning the avatar body, their sense of immersion within the scene and also their confidence in answering to the visual tests/trials. These were measured on a Likert scale with values of 1 representing the highest level of disagreement at each question and 5 representing the highest level of agreement.

More than 80% said they used at least once in the past a virtual reality technology. We speculate that this high percentage is addressed to the fact that most of the participants were students from our academic department.

The sense of body ownership, as assessed in questions 4 and 12 was quite high. The answers to this questions were grouped together after a reliability test (Cronabachs Alpha = 0.856) was performed to prove that the two questions measure the same construct. In the reliability test and the body ownership assessment, the answers of the question 12 were reversed due to the negative way the question is stated. The median score, for the body ownership, as an average in both groups, was found at 3.5 out of 5. The feeling of immersion, as measured in the post-questionnaire based on the answers of the question 3, was high, with a median score of 4 and minimum recorded value 3. In addition, participants in both groups stated that they had understood clearly the process and the instructions of the test. The median scores of the relevant questions (question 1 - reverse answers and question 2) were in both cases 5.

Participants declared that they were confident for their estimates for the visual tests. This was assessed with the post-questionnaire (questions 6, 8 - reversed answers and 11; Chronbachs Alpha = .576). More than 45% were absolutely confident, while the lowest score was 3.67, on a scale from 1 to 5. The median score was 3.66.

None of the participants of the experimental condition replied absolutely positive in the question if he had the feeling that the other human representations in the virtual world were real people (question 5). On a scale from 1 to 5, the maximum score was 4 while the median was 3. This implies that participants' sense for the social presence of the virtual confederates was medium.

A Pearson product-moment correlation coefficient was computed to assess the relationship between the participants' Confidence, as declared by them at question 11 of the post-questionnaire, and their Response Time in all trials of both groups. There was a negative correlation between the two variables, r=-.475, n= 22, p=.025. The more confident the participant felt, the more rapidly he was giving an answer in the trials. No significant difference was found between the Confidence of participants in the control group and the Confidence of the participants in the experimental group (mean difference = .0855, p=.975).

By analyzing the data, results demonstrated no significant distortion observed on participants answers. A percentage of 90.91% of the participants responded correctly to all questions. In total of 264 trials in both groups, only 3 were given a wrong answer (1.14%).

As a next step we would like to investigate whether the participants average Response Time is affected by the responses of agents in the experimental group. A t-test was performed, to compare means of the average Response Time of participants in the trials in which agents were giving a wrong answer (M=.94, SD = 152) with the average Response Time in those trials in which agents were giving a correct answer (M = 1.053, SD = .199). The results demonstrated no statistically significant difference between the two (t(10) = -.950, p=.364).

By plotting the average Response Times of participants at each trial (Figure 4) we observed a pattern in the experimental group while this was not happening in the control group. In Figure 4, the trials in which the agents in the experimental condition were giving a correct answer are marked with a green line, while the red lines mark the incorrect answers by the agents. Our observations, blue rectangles on the Figure 4 (middle), were indicating that whenever a trial in which confederates responded with an incorrect answer (red line) was followed by a trial where the confederated responded with a correct answer (green line), the average Response Time of the participants, were increase drastically. Moreover, these observations were not valid in the corresponding trials at the control group (Figure 4, top).

To investigate further this, we created the ordinal variable Change of Agents Error which is directly computed from Agents Error variable. The Agents Error is a variable that takes the value 0 in the trials in which the agents answered correctly (trials 1, 2, 4, 11), and 1 in the trials that answers of the agents were wrong (trials 3, 5, 6, 7, 8, 9, 10, 12). Change of Agents Error describes the variation of Agents Error in each trial.

When Agents Error value is not changed, compared to its value for the previous trial, the value of Change of Agent's Error is computed to 0. In trials, in which the Agents Error is 1 (agents answered wrong) while in the previous trial was 0 (agents answered correctly), the value of Change of Agents Error is 1. In the same manner, in trials which the Agents Error is 0, while in the previous trial was 1, the value of Change of Agent's Error is -1.

The Change of Agent's Error is an ordinal variable since it indicates the consistency by the agents, towards answering correctly. Change of Agent's Error, as computed based on Agents Error of two consequent answers, is plotted at the graph of Figure 4 (bottom). The Change of Agents Error for the first trial cannot be computed, since there in no previous trial, thus in the following analysis this value is handled as a missing one.

The similarity of the two graphs, plotting the participants' average Response Time (Figure 4, middle) and Change of Agents Error (Figure 4, bottom) for each trial, can be easily observed. To prove this the appropriate statistical analysis was performed. A Pearson product-moment correlation coefficient was computed to assess the relationship between the two variables; Participants Average Response Time and Change of Agents Error. There was a high significant correlation between the two variables in experimental group, r=.903, n=11, p<.001. This means that the greater was the value of Change of Agents Error, more is the time needed for the participants to respond.

To verify that this is addressed in the existence of agents and their answers, a similar test, a Pearson product-moment correlation coefficient between Participants Average Response Time and Change of Agents Error was also performed for the control group. The results for the control group, demonstrating no significant correlation (r=.092, p=.789).

Moreover, to double check that the significant correlation that observed in the experimental group was due to the social influence from the agents and not due to other external factors (e.g. difference on difficulty of the visual test of each trial) we also performed a partial correlation. We controlled the participants average Response Time in control group, on the relation

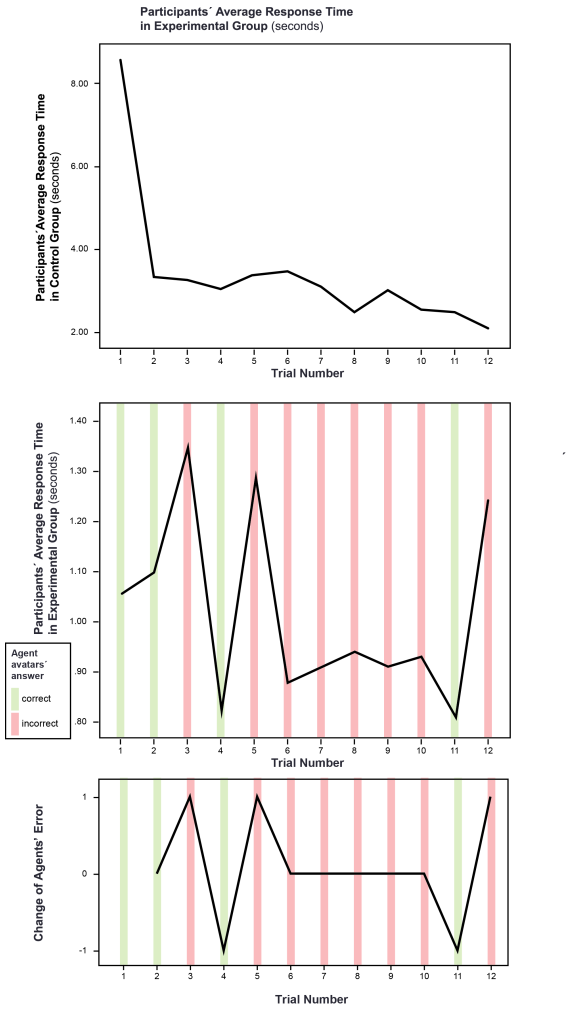

Figure 4: Participants' average Response Time in each trial for the control group (top) and the experimental group (middle) with the corresponding Change of Agents Error in each trial.

between Change of Agents Error and the participants average Response Time in the experimental group. Results are demonstrating a partial correlation of r=.904, p<.001. This proves that the correlation between the two variables (Change of Agents Error, participants average Response Time) in the experimental group, is significant, even if we keep constant the values of the variable participants' average Response Time of the control group.

4 Discussion

This experiment was designed to investigate whether social pressure from a majority consist-

ing of agents may influence the judgment of a person in a virtual environment.
The correct answers, as in the original Asch experiment, were deliberately obvious and undeniable, so the possible distortion on participants' responses would constitute extreme form of social compliance. In combination with the relatively low social presence [1], we were speculating that the level of social pressure which the participants received would not be high enough to make them displace their answers.
This speculation was confirmed by our results. Participants were not replied according to the responses of the majority. This differs from the finding of a previous study [11] in which avatars, controlled by real people, were used as confederates and not agents which are used in our case. Although the correctness of the answers of those who participated in the experiment were not affected by the virtual agents, the time it took them to respond to the trials has been affected. In trials where the agents gave the wrong answer, whereas in the previous test were answered correctly, the average Response Time of participants was significantly higher. The reverse is also observed. In trials where the agents were giving a correct answer, while in the previous trial had answered wrong, the average Response Time of participants was significantly lower.
This could be interpreted as a momentary force on the participants answers, affected by the reliability of agents and their consistency in providing correct or wrong answers. When the agents appear not to be reliable, that is in consequent trials replied with a different manner (i.e. in one trial with a correct answer and the other with a wrong answer or vice versa), a big variation in participants Response Time, is observed between times of consequent trials. If the agents are breaking the reliability (previous answer was correct and the current answer is wrong) then the Response Time of the participants drastically increases. On the other hand if the agents are recovering the reliability (previous answer was wrong and the current answer is correct) the Response Time of the participants decreases drastically. Moreover, if the agents are consistent in the manner the give an answer to consequent trials, that is either they give continuously correct answers or they give continuously wrong answers, the Response Time of the participants does not change significantly.

4.1 Limitations and Future Work

An important limitation of this study is that we dont provide the participant with the ability to fully control his/her virtual body. This can be achieved by using real-time full body motion tracking technology and mapping the participant's movements to those of his virtual avatar. We speculate that increasing the level of immersion, would increase the sense of self presence (illusion of being there) [13] [1] and contribute in finding more significant and similar to the physical world results. This speculation will be the subject of a future study.

References

[1] Jim Blascovich, Jack Loomis, Andrew C Beall, Kimberly R Swinth, Crystal L Hoyt, and Jeremy N Bailenson. Immersive Virtual Environment Technology as a Methodological Tool for Social Psychology. 13(2):103–124, 2002.

[2] Christopher J Wilson, Alessandro Soranzo, and S Sheffield. The Use of Virtual Reality in Psychology : A Case Study in Visual Perception. *Computational andMathematicalMethods inMedicine*, 2015, 2015.

[3] Jeremy N. Bailenson and Jim Blascovich. Avatars. In *Encyclopedia of Human-Computer Interaction, Berkshire Publishing Group*, pages 64–68. Berkshire Publishing Group, 2004.

[4] Astrid M. Von Der Pütten, Nicole C. Krämer, Jonathan Gratch, and Sin H. Kang. "It doesn't matter what you are!" Explaining social effects of agents and avatars. *Computers in Human Behavior*, 26(6):1641–1650, 2010.

[5] Jeremy N. Bailenson, Nick Yee, Jim Blascovich, Andrew C. Beall, Nicole Lundblad, and Michael Jin. *The Use of Immersive Virtual Reality in the Learning Sciences: Digital Transformations of Teach-*

ers, Students, and Social Context, volume 17. 2008.

[6] Rosanna E. Guadagno, Kimberly R. Swinth, and Jim Blascovich. Social evaluations of embodied agents and avatars. *Computers in Human Behavior*, 27(6):2380–2385, 2011.

[7] Crystal L. Hoyt, Jim Blascovich, and Kimberly R. Swinth. Social Inhibition in Immersive Virtual Environments. *Presence: Teleoperators and Virtual Environments*, 12(2):183–195, 2003.

[8] Mel Slater, Angus Antley, Adam Davison, David Swapp, Christoph Guger, Chris Barker, Nancy Pistrang, and Maria V. Sanchez-Vives. A virtual reprise of the Stanley Milgram obedience experiments. *PLoS ONE*, 1(1), 2006.

[9] Solomon E Asch. Effects of group pressure upon the modification and distortion of judgments. *Groups, leadership, and men*, 1951.

[10] Solomon E. Asch. Opinions and Social Pressure. *Scientific American*, 193(5):31–35, 1955.

[11] Rebecca Rayborn-Reeves, Jennifer Wu, Sara Wilson, Beth Kraemer, and Philipp Kraemer. Do As We Do, Not As You Think: The Effect of Group Influence on Individual Choices in a Virtual Environment. *Journal Of Virtual Worlds Research*, 6(1), 2013.

[12] Robert S. Baron, Joseph a. Vandello, and Bethany Brunsman. The forgotten variable in conformity research: Impact of task importance on social influence. *Journal of Personality and Social Psychology*, 71(5):915–927, 1996.

[13] Mel Slater. Place illusion and plausibility can lead to realistic behaviour in immersive virtual environments. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, 364(1535):3549–3557, 2009.