

# A Study in Virtual Reality on (Non-)Gamers' Attitudes and Behaviors

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## ABSTRACT

Virtual Reality (VR) constitutes an advantageous alternative for research considering scenarios that are not feasible in real-life conditions. Thus, this technology was used in the presented study for the behavioral observation of participants when being exposed to autonomous vehicles (AVs). Further data was collected via questionnaires before, directly after the experience and one month later to measure the impact that the experience had on participants' general attitude towards AVs. Despite a non-significance of the results, first insights suggest that participants with low prior gaming experience were more impacted than gamers. Future work will involve bigger sample size and refined questionnaires.

**Keywords:** Virtual Reality. Autonomous vehicles. Human-centered design

**Index Terms:** H.5.1 [Information Interfaces and Presentation]: Multimedia Information Systems – Artificial, augmented and virtual realities; H.1.2 [User/Machine Systems]: Human factors; H.5.2 [User Interfaces]: User-centered design

## 1 INTRODUCTION

Since experiments including AVs in authentic real-life conditions are barely feasible, VR has been used for the presented study (i) to observe user behaviors of participants when being exposed to AVs as pedestrians in two scenarios and (ii) to investigate to which extend the VR experience impacted the participants' attitudes towards AVs.

## 2 RELATED WORK

VR has already been used to investigate attitudinal changes of participants e.g. regarding intention to visit tourist destinations [9]. Blascovich, Barbara, and McCall [1] conclude in their study that VR experiments can lead to participants' attitude change or even persuasion (e.g. increased agreeing and persuasion to same gendered agents of a familiar communication group).

The presented case study focuses on attitudes towards fully autonomous vehicles (AV). In this research field, current main data collection methods are surveys without behavioral experiences involving AVs [7]. It is anticipated that the lack of immersive experiences for the participants may impact the results since behaviors and attitudes are interlinked [11].

VR experiments have already been conducted to measure behaviors and attitudes towards AVs [2], [8]. These studies suggest that, in contrast to other data collection methods like

surveys or screen-based simulations, VR constitutes an advantageous alternative to simulate immersive experiences to measure behaviors and attitude changes.

## 3 METHOD

The VR test setup consisted of an empty area of 5.0m x 4.2m with two infrared and laser trackers. One participant was tested at a time. After a briefing and collection of consent, the participants were equipped with a head-mounted display and started with a tutorial. Then, in the first scenario, the participants had the task to cross a one-way street via a zebra crossing while an AVs were approaching (Figure 1).



Figure 1: Participants' first person view in the virtual environment

In the second scenario, the participants stood on a one-way street, facing one direction of the street. After a countdown, the participants were requested to turn around. While doing so, AVs approached with various speeds and breaking distances.

As data collection method, a questionnaire consisting of ten questions had to be filled out three times by the participants (based on [3]), 1) before the conduct of the experiment ( $T_{bef}$ ), 2) directly after the experiment ( $T_{aft}$ ), and 3) one month after the experiment ( $T_{+1m}$ ) for measuring short and long-term impacts. Questions were for example: "I would feel safe to cross the road in front of an AV". In addition, information about age, gender, prior gaming experience and prior VR experience was collected. Lastly, the researchers observed the participants while conducting the VR experiment in order to investigate reactions and behaviors to compare them to the outcomes of the questionnaires.

The VR experiment was approved by the IRB of Nanyang Technological University of Singapore, No. 2018-06-048.

## 4 RESULTS

19 people (37% female, 63% male) with an age range of 23 to 34 years old ( $M = 26.80$ ,  $S.D. = 2.78$ ) from the researchers' laboratory participated in the experiment (the participants were not involved in the development of the study). 37% of the participants had moderate to no prior gaming experience and 63% stated to have high prior gaming experience. 95% of the participants stated to have moderate to no prior VR experience and 5% stated to have high prior VR experience.

The impact on attitudes towards AVs was investigated in correlation to the participants' prior gaming and VR experiences. Since the authors focused on the magnitude of the impacts, and not whether the impact was positive or negative, the absolute values of the  $\Delta$  columns were compared (Table 1).

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Table 1: Average scores and absolute magnitude of  $T_{bef}$ ,  $T_{aft}$ , and  $T_{+1m}$  separated in prior gaming experience

Prior gaming experience	$T_{bef}$	$T_{aft}$	$T_{+1m}$	$\Delta$ $ T_{aft} - T_{bef} $	$\Delta$ $ T_{+1m} - T_{bef} $
Very high	12	13.6	13.6	1.6	1.6
High	20	19	19.4	1	0.6
Moderate	21	22	22	1	1
Low	12	9	7.6	3	4.4
None	5	2	0	3	5

The results in Table 1 are not statistically significant but the following initial statements have been formulated (and will need to be further investigated): There were minimal differences in the average scores of participants with moderate to very high prior gaming experience ( $\Delta=0.6$  to  $\Delta=1.6$ ). However, the differences in average scores for participants with low or no prior gaming experience from  $T_{bef}$  to  $T_{aft}$  were  $\Delta=3$  and from  $T_{bef}$  to  $T_{+1m}$   $\Delta=4.4$  and  $\Delta=5$ . This suggests that participants with low to no prior gaming experience were more impacted by the VR experiment than participants with high to very high prior gaming experience.

The second part of the experiment focused on how authentic participants behave in VR in comparison with real life. The researchers' observations of behaviors supported the indications of the questionnaires since the participants with high and very high prior gaming experience tended to behave and react not as "authentically" as the non-gamers during the experiment (e.g. perform a high step to enter a sidewalk) (Figure 2).



Figure 2: Participants performing a high step to enter a sidewalk

## 5 DISCUSSION

The behaviors of gamers confronted to a virtual environment have already been investigated in several studies and their conductors already came to the conclusion that gamers do not act similarly to non-gamers as participants. Gamers have a lower psychological investment [5] and engage themselves differently into virtual environments than non-gamers [6]. The reason of the different behaviors in VR may result from an inhibition of emotional response [5] as soon as the participant has a knowledge of the virtual environment. Thus, for future studies in which the authors will investigate further behaviors towards AVs and possible extrapolation to real-life behavior, exclusion or restriction criteria could be applied for gamers.

The authors had no intention to positively or negatively influence the attitudes of the participants towards AVs. This may explain why the impacts were partly positive and partly negative. Subsequent investigations will be grounded in research that focused on designing virtual environments as a mean to achieve persuasive goals e.g. for health, educational purposes [4], [10].

One limitation of the study was the small sample size of participants, which may have hindered a generalization of the results. Therefore, a refined experiment will be conducted with a bigger sample size that allows statistical analysis of results. A further limitation is the degree to which the participants were biased prior to the VR experiment, since all participants worked in the field of autonomous transportation. It is anticipated that unbiased participants would have averagely less positive attitudes towards AVs.

## 6 CONCLUSION

In the field of autonomous transportation, VR enables research on behaviours and attitudes without the need of physical prototyping. The presented study showed that behavioural experiences VR involving AVs can have an impact on attitudes towards AVs. The authors noticed changes in magnitude for participants who consider themselves as non-gamers. The following improvements will be implemented for further studies: 1) a bigger sample size of participants with low to moderate gaming experience and low bias towards AVs will be recruited, and 2) the questionnaires will be refined to more specifically identify which kind of impact the VR experience has on the participants (positive or negative). Further studies that incorporate the stated set of recommendations are planned in order to collect significant data and thus, statistically prove the suitability to impact attitudes with the help of VR.

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