ABSTRACT

How does haptic feedback during a human-virtual human interaction affect emotional arousal in virtual reality? In this between-subjects study, we compare haptic feedback and no haptic feedback conditions in which a virtual human “bumps” into the participant in order to determine the influence of haptic feedback on emotional arousal, sense of presence, and embodiment in virtual reality, as well as compare self-report measures of emotional arousal to those objectively collected via event-related galvanic skin response (GSR) recordings. We plan to extend the current preliminary study by adding three more conditions as described in the future work section. Participants are students age 18-30 with at least moderate experience in virtual reality. Preliminary results indicate significant differences in presence and embodiment between haptic feedback and no haptic feedback groups. With our small sample size at the current time, GSR does not show significant differences between haptic and no haptic feedback conditions.

Index Terms: Human-centered computing—Human computer interaction (HCI)—Interaction paradigms—Virtual reality

1 INTRODUCTION

Virtual reality has high potential for psychosocial research [4]. Therefore, a better understanding of the influences and potentially required realism of haptics on emotional arousal and presence may aid in the creation of more believable human-virtual human interactions in virtual reality. Haptic feedback is present in many virtual reality games and experiences, but specific factors such as timing, intensity, and position accuracy remain underexplored. Furthermore, emotional arousal, which may or may not be associated with presence, appears lesser explored.

Previous studies have shown that haptic feedback in virtual reality can increase sense of presence. In the wobbly table study [2], participants who experienced slight movements of a physical table during their interaction with a virtual human experienced significantly higher self-report levels of presence than did those who felt no physical movements of the table. Additionally, Ryge et al. [3] found that higher fidelity haptic feedback felt from baseballs in virtual reality increased the perceived realism of the baseball. But how might haptic feedback influence emotional arousal, and how does more realistic haptic feedback compare to illogical or inaccurate haptic feedback? This study seeks to link emotional arousal recorded objectively via galvanic skin response (GSR) with subjective self-report emotional arousal, presence, and embodiment.

2 METHODOLOGY

Upon arriving, participants are briefly introduced to the project, and the purpose of the equipment as well as the experimental procedure are explained. While the participant completes a pre-questionnaire (concerning sex, age, and prior VR experience), the experimenter adjusts the self-avatar to most closely match the participant’s skin tone, as we wanted to provide participants with a higher body ownership experience [8]. Then, the participant is fitted with the bHaptics “Tactsuit,” a haptic gaming vest which allows precise control of haptic feedback, and is controlled with a Unity3D plugin. Next, a Shimmer GSR sensor is attached to the participant’s non-dominant hand, with the two electrode sensors fit securely on the index and middle finger. The participant with all necessary equipment can be seen in Figure 1.

The participant is instructed to relax, try not to talk or move, and breathe normally, as these are the recommended instructions for minimizing muscular artifacts [1] [7]. The sensors are connected to iMotions biometrics recording and analysis software via Bluetooth. Within iMotions, the screen output of the virtual reality scene is captured and observable by the experimenter throughout the study (see Figure 2). The experimenter uses a timer to verify that the 2-minute baseline recordings have been obtained, and then starts the VR scenario.

2.1 Event-Related GSR

Once the participant confirms that he or she feels comfortable and is ready to begin, he or she is instructed to relax for 2 minutes, while baseline GSR is recorded. After this 2-minute period, the experimenter starts the virtual reality scenario that consists of 2 phases: exploratory, and experimental. In the exploratory phase,
suggest a statistically significant difference for haptic feedback ($M = 5.31, SD = 0.85$) and no haptic feedback ($M = 3.31, SD = 0.52$) conditions; $t(3) = 8.0, p = 0.004$.

To analyze emotional arousal from event-related GSR, we looked at the 1-5 second time window immediately following the onset of the stimulus [1], in this case, the onset of virtual human collision, which occurs 6 times at 20-second intervals, starting at 161 seconds into the recording for every participant. For example, for the 161-second stimulus onset time, the time window 162-167 seconds was analyzed for the existence of GSR. While our current analytic approach involves simply “more” or “less” emotional arousal between participants in different conditions based on quantity of peaks, it may be interesting to consider GSR latency to onset of peak (the time it takes to reach the peak response), especially as the data from the more nuanced haptic feedback conditions (described in Section 4) is collected. Our results for event-related GSR indicate non-significance in this early stage of the study between haptic feedback ($M = 3.75, SD = 1.85$) and no haptic feedback ($M = 3.12, SD = 1.89$) conditions; $t(3) = 0.404, p = 0.713$. As we continue the study, an appropriate $N$ may show significant differences in GSR between haptic feedback and no haptic feedback groups.

4 CONCLUSION AND NEXT STEPS

An overview of our experiment for investigating emotional arousal, presence and embodiment in haptic feedback and no haptic feedback conditions during human-virtual human interactions in virtual reality is presented. In this work, the methodology, technical set-up, as well as descriptions of the experimental procedure and specific virtual reality scene are presented.

As data collection continues, we plan to add the following conditions to the experiment: haptic feedback with inaccurate position (feeling the bump on the wrong side of the body: felt on the left side of the body, as the virtual human collides with the right side of the participant’s body), haptic feedback with inaccurate intensity (200% increase from accurate haptic feedback), and haptic feedback with inaccurate timing (1 second delay between haptic feedback and human-virtual human collision). Preliminary data suggests a more engaging experience in virtual reality with the addition of haptic feedback, and paves the way for the continuation of our data collection and analysis concerning all five haptic feedback conditions.

REFERENCES