Effects of Ageing and Sound on Perceived Timing of Human Interactions

Eugenie Roudaia[1], Ludovic Hoyet[2], David McGovern[1], Carol O'Sullivan[2], Fiona N. Newell[1]

1. Trinity College Institute of Neuroscience, Trinity College Dublin, Dublin, Ireland
2. Department of Computer Science, Trinity College Dublin, Dublin, Ireland

Figure 1: *Did the character being pushed react too early or too late? Still frames are showing the point of contact in videos with late, correct and early reactions.*

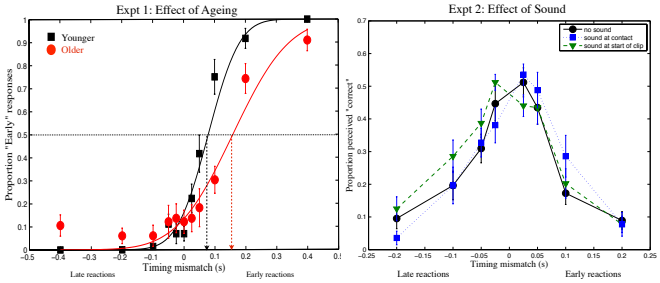

Figure 2. *Older observers are less sensitive to timing mismatches. Both groups tend to perceive 'early' reactions as correct. The timing of a punch sound can bias the perceived correct timing toward early or late reactions.*

1. Introduction

Variations in the timing and speed of movements in human interactions carry important social information. For example, seeing one player push another player at a football game, we can deduce whether the player being pushed resisted or anticipated the oncoming push based on subtle differences in the timing and velocity of movements of both players. With the development of computer animations of human characters, it is important to understand the sensitivity and limits of human perception in such interactions to accurately portray human interactions.

Although the vast majority of research in perception is conducted with young adults, older adults constitute an increasingly growing proportion of the population worldwide. It is now understood that healthy ageing affects the sensitivity in a wide range of visual tasks. Using simplified stimuli, previous studies have shown that older adults are less sensitive to different types of visual motion. Very little is known about older adults' ability to perceive subtle differences in human movement. A recent study showed that young adults could detect timing errors as short as 150ms in human interactions [Hoyet et al., 2012]. Here, we examined whether the sensitivity to timing mismatches in human motion changes with healthy ageing. In addition, we investigated the effect of sound on the perceived timing of these interactions.

2. Methods

Stimuli consisted of computer animations of one character (pusher) approaching another character (target) and pushing him on the back, causing the target to step forward. The characters were animated using motions captured from real pushing interactions. Timing mismatches were introduced at the point of contact to create animations where the target's reaction was either early or late by a variable duration ranging from 25-400ms [Hoyet et al., 2012]. In Experiment 1, a 2-alternative forced-choice procedure was used where younger and older participants viewed a video clip with timing mismatches ranging 0 to ±400ms and judged whether the target's reaction was *late* or *early*. In Experiment 2, a 2-interval forced-choice procedure was used where participants saw the video clip with the correct timing (0ms mismatch) and an interaction with a timing mismatch from ±25ms to ±200ms in random order and judged whether the *first* or *second* video clip had the correct timing. To investigate the effect of sound on these judgments, participants performed this task in three sound conditions: no sound, a punch sound at the time of contact, and a punch sound at the beginning of the video clip. Sound conditions were performed in block-randomized order.

3. Results

In Experiment 1, the proportion of "early" responses was fit with a cumulative Gaussian function for each participant to extract the point of subjective 'correct' timing (PSE) and the slope of the psychometric function, which represents the sensitivity to timing mismatches. The PSE was biased towards early reactions in both groups, but the bias was significantly greater in older participants (mean = 193ms) than in younger participants (mean = 79ms) [$F(1,20) = 13.6$, $p = 0.001$]. Older participants also showed overall poorer sensitivity to timing [$F(1,20) = 4.78$, $p = 0.04$]. Results in the no sound condition in Experiment 2 confirmed these findings: younger participants reached 80% accuracy with timing mismatches as short as 100ms, while older participants required more than 200ms mismatch to detect both early and late reactions. The timing of the sound influenced performance: compared to the no sound condition, the punch sound at the point of contact biased the perceived correct timing to early reactions, while the sound at the beginning of the video clip had the opposite effect.

4. Conclusions

We found that older observers are less sensitive to the timing of human interactions, which may impact their ability to accurately interpret their social content. These results also suggest that older adults will be less likely to notice defects in the timing of computer graphics animations. We also found that the timing of a sound had a significant impact on the perception of visual interactions, suggesting that the audiovisual content of animations should be carefully synchronized to avoid misinterpretations.

5. References

HOYET, L., MCDONNELL, R., AND O'SULLIVAN, C. 2012. Push it Real: Perceiving Causality in Virtual Interactions. *In ACM Transaction on Graphics (SIGGRAPH 2012)*, 31(4).

SAP 2013, August 22 – 23, 2013, Dublin, Ireland.

ACM 978-1-4503-2262-1/13/08