The Impacts of Avatar Movements in Different Velocities on Users' Performances Related With Body Perception: Preliminary Results from a Novel Desktop Application

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***Abstract*--In our study, a desktop software program was developed to assess the right-left distinction from different personal perspectives. It was aimed to evaluate the ability of users to make right-left body movements of the avatar on their own bodies according to differently categorized perspective perceptions. 146 healthy volunteers were included into the study. Avatar movements were categorized into different view levels and direction of views and presented into two different conditions named as "normal" and "fast". As a result of changes made to the velocity of avatar movements, users responded with higher values in terms of shoulder abduction angle values and faster in terms of reaction time. We can conclude that the velocity is one of the important parameters that effect the physical performances of the users on seeing avatars from different perspectives.**

***Keywords*--body image, body recognition, desktop application, imagery, perspective, virtual reality, skeleton extraction models**

I. INTRODUCTION

"Personal Perspectives" is about understanding what the world looks like from the other person's visual perspective by mentally adjusting to the other's spatial perspective [1]. Psychometric studies on spatial ability address this ability in two contexts: spatial visualization and spatial orientation [2]. While spatial visualization is defined as the ability to imagine the spatial forms of objects or the movement of objects; spatial orientation is the ability of the observer to imagine perspectives of images of objects from different directions. In spatial orientation, the mental transformation strategy can be manipulated in its self-centred or non-self-centred forms.

There are a limited number of studies in the literature that evaluate perspective perception through the right-left distinction. Studies that address this issue examine body representation information from personal perspectives, first person perspective (egocentric reference frame) or third person perspective (allocentric reference frame) [3,4]. On the other hand, studies on virtual reality technology focused on the research areas such as telepresence, embodiment, body ownership, and body image. According to these studies, modifying avatar's physical properties [5] or movement characteristics [6,7] may affect the users' performance. These results may be explained with the effect of the virtual reality technology on the users' capability of integration with the avatar's body, increasing the immersion of the user within the virtual reality environment [8].

In our study, a desktop software program was developed to evaluate the right-left distinction from different point of views and direction of views. It was aimed to evaluate the ability of users to make right-left body movements of the avatar on their own bodies according to differently categorized perspective perceptions. It was hypothesized that changing avatar's velocity would affect the user's performance.

II. METHOD

A. Features of the Desktop Application

Within the scope of the study, avatar movements were developed on the UNITY platform with different perspectives and different view levels in order to evaluate the perspective perception of the users. The users are asked to adapt the avatar's body to their own bodies and perform the same limb movement (Shoulder Abduction) that the avatar performed on their own bodies. Limb movements of the users are recorded with a camera of the computer (Monster Tulpar T5 V22.1) and the movement patterns are recognized by the software program. Movement angle value (º) and reaction time (ms) for right and left side are recorded. Animation velocity, number of animations, number of repetitions of the animation, and interval time between animations are presented on the entrance screen as adjustable parameters.

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B. Participants

The criteria for the inclusion of the participants in the study were determined as follows; being at least a primary school graduate, between the ages of 18 and 65, scoring with a minimum score of 21 on the Montreal Test of Cognitive Assessment (MoCA) [9]. The criteria for the participants not to be included in the study were determined as follows; having vision problems, having any mental, neurological, or musculoskeletal problems, scoring less than 21 on the MoCA, not being able to perform activities that require long-term attention, not being able to perceive commands and using sedative drugs and/or their derivatives.

C. Test Procedure

The user was positioned in a standing position where the camera could identify the body. When the participant was ready, the button of "start" was pressed. One orientation session was applied to explain the test procedures. With that session, information about how the animation movements appeared on the screen and how the user followed the instructions was explained to each participant. Participants were asked to adapt the avatar position whenever they saw on the computer screen to their own bodies and perform the same limb movements. On the real test phase, avatar movements were categorized into different levels of views and direction of views. Two different conditions named as "normal" and "fast" were applied in randomized order. A total of 40 animations with 20 animations in each set, were shown. One session was consisted of random right-left shoulder abduction movements. The two conditions of normal and fast were counter balanced.

D. Ethics Statement

Ethical approval for the study has been taken from the Istanbul Medipol University Non-Interventional Clinical Trials Ethics Committee (Approval no: E-10840098-772.02-6760) and a written informed consent was obtained from the subjects according to the Declaration of Helsinki.

E. Statistical Analysis

Statistical analysis was made by Jamovi (2.3.28.0) software program. Statistical significance was evaluated at a level of $p<0.05$. The analysis of variables using numerical measurement was defined as arithmetic mean and standard deviation (X±SD). "T-test" or "Wilcoxon Test" was used for 2-group comparisons. "Repeated Measures ANOVA" test was performed to compare variables across three independent groups. "Bonferroni Correction" was applied in post-hoc comparisons.

III. RESULTS

A total of 152 participants were evaluated within the scope of the study; 146 of them (female/ male (%) 50.68/49.32; mean age 25.8±7.45 years) were suitable for the study. There was no statistical difference in the gender distribution of the participants ($p>0.05$). A statistically significant difference was found in terms of dominant hand preferences ($p<.001$). Accordingly, the "right" dominant hand was in the majority (89.73%). A statistically significant difference was also found in terms of education level ($p<.001$). Accordingly, it was detected that the university education level was in a high level (82.19%).

A. Perspective from different level of views: outcomes with degree of movement and reaction time

The 5 (Level of view: Top Angle, High Angle, Eye Level, Low Angle Bottom Angle) x 2 (velocity of avatar: Normal, Fast) ANOVA design was used to examine the differences in movement angle values in between different level of view at different avatar velocities. Accordingly, a statistical difference was detected in terms of level of view ($F_{(df=3.29\text{-}62.57)}=84.11$; $p<0.001$; $\eta^2=0.613$) and avatar velocity ($F_{(df=1\text{-}19)}=21.93$; $p<0.001$; $\eta^2=0.029$). Post-hoc comparisons revealed that statistical differences in between "Bottom Angle" and all the other angles ($p<0.001$ for 4 category comparisons) (Figure 1).

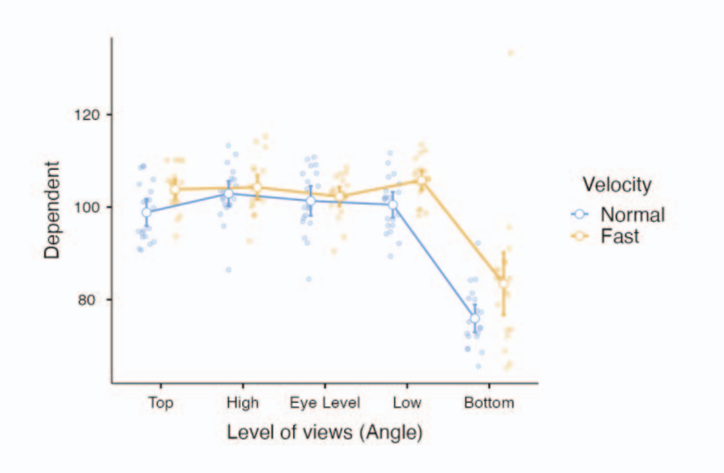

Fig. 1. Degree of movement outcomes for level of view categories

The 5 (Level of view: Top Angle, High Angle, Eye Level, Low Angle Bottom Angle) x 2 (velocity of avatar: Normal, Fast) ANOVA design was used to examine the differences in reaction times in between different level of view at different avatar velocities. Accordingly, statistical differences were detected in terms of level of view ($F_{(df=2.96\text{-}56.24)}=227.21$; $p<0.001$; $\eta^2=0.746$) and avatar velocity ($F_{(df=1\text{-}19)}=9.29$; $p=0.007$; $\eta^2=0.015$). Post-hoc comparisons revealed that statistical differences in between "Bottom Angle" and all the other angles ($p<0.001$ for 4 category comparisons) (Fig. 2).

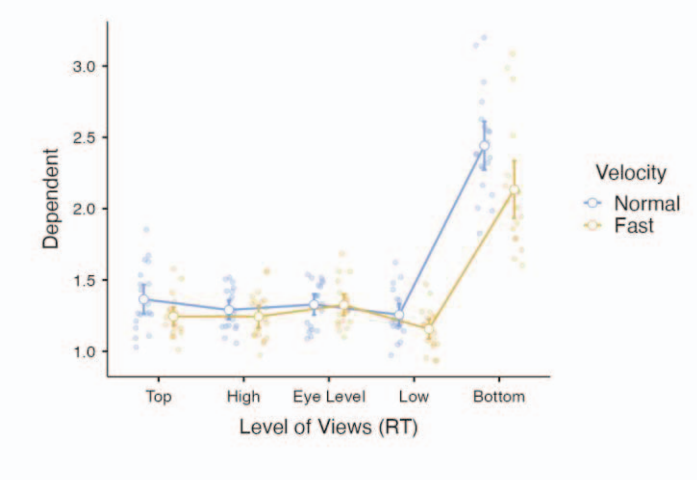

Fig. 2. Reaction time outcomes for level of view categories

B. Perspective from different directions of views: outcomes with degree of movement and reaction time

The 8 (Directions of views: 0˚, 45˚, 90˚, 135˚, 180˚, 225˚, 270˚, 315˚) x 2 (Avatar velocity: Normal, Fast) ANOVA design was used to analyse the differences in movement angle values at different avatar velocities in different directions of views. Accordingly, statistical differences were detected in terms of directions of views ($F_{(df=4.66\text{-}88.51)}$ =2.404; $p=0.047$; $\eta^2=0.052$) and avatar velocity ($F_{(df=1\text{-}19)}$=29.646; $p<0.001$ $\eta^2=0.065$). When post-hoc comparisons were performed regarding directions of views, no statistically significant difference was found (p>0,05) (Fig. 3).

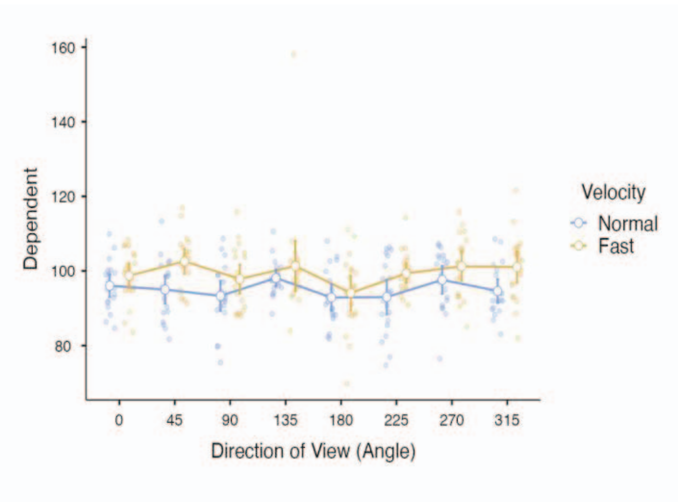

Fig. 3. Degree of movement outcomes for direction of view categories

The 8 (Directions of views: 0˚, 45˚, 90˚, 135˚, 180˚, 225˚, 270˚, 315˚) x 2 (Avatar velocity: Normal, Fast) ANOVA design was used to analyse the differences in reaction times at different avatar velocities in different directions of views. Accordingly, statistical differences were detected in terms of directions of views ($F_{(df=4.71\text{-}89.49)}$ =3.238; $p=0.011$; $\eta^2=0.070$) and avatar velocity ($F_{(df=1\text{-}19)}$=11.867; $p=0.003$; $\eta^2=0.042$). When post-hoc comparisons were performed regarding directions of views, a statistically significant difference was found between 0 and 180 degrees in terms of reaction time (t= -3.9447; p=0.024) (Fig. 4).

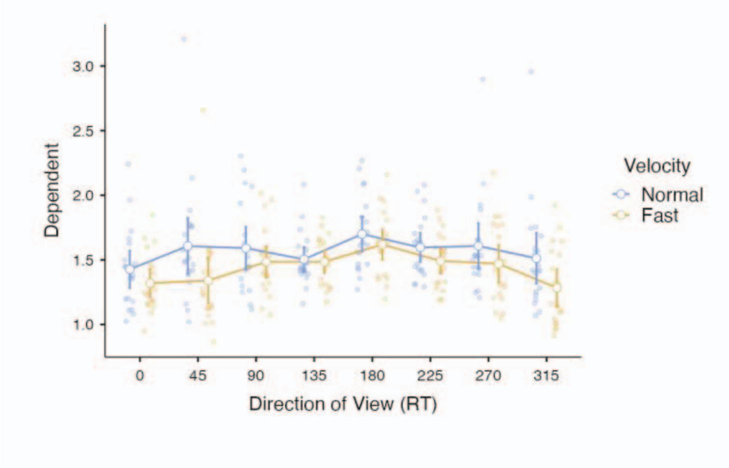

Fig. 4. Reaction Time outcomes for direction of view categories

IV. CONCLUSION

The fundamental achievement of this study is to show enhancing the users' performances on identifying right and left side of the body in different perspectives by modifying the avatar's velocity. As a result of changes made to the velocity of avatar movements, users responded with higher values in terms of shoulder abduction angle values and faster in terms of reaction time. In the responses given for the "bottom angle" category of the level of view, the least angle values and slowest responses were reached in terms of reaction time. This is an indication that this category of perspective requires more mental effort. Additionally, when looking at the reaction time findings of direction of view, differences were found when the avatar was presented with a direction of view of 0 and 180 degrees. This finding confirms that mental rotation tasks are easy from a first-person perspective and difficult from a third-person perspective. As a result, we can conclude that the velocity is one of the important parameters that effect the physical performances of the users on seeing avatars from different perspectives.

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