**Measurement**

To address the question of how the design of eyes behaviors affect human’s perceptions of robot state of whether it is receiving voice command, an online survey was designed to collect data and Principal Component Analysis(PCA) was used to extract and retain significant factors. All questionnaire, full data matrix, eigenvalues and Scree plot, factor matrix, scales with corresponding items and α values were included in the Appendix.

**Concept**

Three concepts were interesting to measure, which were 1) **Attentiveness**: How much one feels that he/she draws robot’s attention after giving voice command to it when it’s conducting a task. 2) **Respect**: How much one feels that he/she is treated respectfully when giving voice command to the robot. 3) **Cooperativeness**: How much one feels that the robot is willing to receive his/her voice command when it’s conducting a task.

**Survey**

A survey of 36 questions were designed, including 7 questions using 7 Likert-scale for each concept, 5 general questions and 10 questions about participant. Google Forms was used and published on social media to collect data and 31 responses were received. Categorical variables were designed in the last two pages of the questionnaire.

Variables were formatted for data analysis. Explanation of formatted variables was that the first word indicated the perception of robots or the feeling of participant. To be more specific, “receiving” and “willing” meant that participant thought that the robot was receiving and willing to receive his/her voice command respectively, while “respect” meant that participant felt being treated respectively. The second term in all the formatted variables described the robot’s behavior. “Pause” meant that the robot paused the task it’s conducting; “brightening”, “blinking” and “circling” indicated the robot’s eyes’ state respectively while “\_eyes” and “\_behaviors” indicated that the robot did not change eyes behaviors or any behaviors respectively.

**Data Analysis**

Data was analyzed using PCA on RStudio(Version 1.0.136). As a result, 8 factors were retained for further analysis. The eigenvalues of these 8 factors were 7.645423105, 5.091981440, 1.655815765, 1.441383281, 1.387022228, 1.073873009, 0.839553063 and 0.583507233 specifically. Therefore, the number of factors was chosen to be **8**. These 8 factors were rotated and loadings of variables on each factor were calculated, the result was shown in the factor matrix. For scale construction, **r > 0.3** was used as the cutoff point to eliminate trivial items and **r > 0.5** as the cutoff point to identify three provisional scales. Cronbach’s α was used to test scale reliability with **α > 0.70** to be considered acceptable.

**Scale Reliabilities**

The following 3 scales were analyzed to be provisional with **α > 0.70:**

***1) Snub***was comprised of 6 Likert-scale items: receiving.\_eyes, receiving.\_behaviors, respect.\_eyes, respect.\_behaviors, willing.\_eyes and willing.\_behaviors. The index was very reliable with Cronbach’s **α = 0.96**. This showed that if the robot was busy conducting a task and the participant was giving voice command to it, but the robot did not change its behaviors except the actions for conducting its original task, it gave participant the perception that the robot ignored the voice command, which was the opposite to **Cooperativeness**.

***2) Listening***was comprised of 3 Likert-scale items: receiving.circling,respect.circling and willing.circling. The index was very reliable with Cronbach’s **α = 0.90**. This indicted that if the robot was circling, it gave participant the perception that the robot was listening to the voice command. Similar to traditional computer interface, circling was mainly used as the sign of processing,

***3) Observing*** was comprised of 4 Likert-scale items: receiving.brightening, receiving.blinking, respect.brightening and respect.blinking. The index was very reliable with Cronbach’s **α = 0.84**. Lights brightening was often shown as aware of or welcome one’s presence while blinking potentially indicated one had been observing something or someone for a certain amount of time.

One interesting finding was that both ***Listening*** and ***Observing*** contributed to the concept of **Attentiveness**. But to better support Attentiveness, more items from social or psychology science should be taken into considered such as behavior of turning one’s eyes’ orientation towards the speaker.

**References**

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