Do Robots Distract us as much as Humans? The Effect of Human-like Appearance and Perceptual Load

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ABSTRACT

Attention is an important mechanism for solving certain tasks, but our environment can distract us via irrelevant information. As robots increasingly become part of our lives, one important question is whether they could distract us as much as humans do, and if so to what extent. To address this question, we conducted a study in which subjects were engaged in a central letter detection task. The task irrelevant distractors were pictures of three agents; a mechanical robot, a human-like robot, and a real human. We also manipulated the perceptual load to investigate whether the demands of the task influence how much these agents distract us. Our results show that robots distract people as much as humans, as demonstrated by significant increase in reaction times and decrease in task accuracy in the presence of agent distractors as compared to the situation when there was no distractor. However, we found that the task difficulty interacted with the human-likeness of the distractor agent. When the task was less demanding, the agent that distracted most was the most human-like agent, whereas when the task was more demanding, the least human-like agent distracted the most. These results not only provide insights about how to design humanoid robots but also sets as a great example of a fruitful collaboration between human-robot interaction and cognitive sciences.

CCS CONCEPTS

• Human-centered computing • Human-computer interaction (HCI) • HCI design and evaluation methods • User studies • Empirical studies in HCI

KEYWORDS: Humanoid robots, attention, human perception, perceptual load, human-like appearance, robot design, cognitive psychology

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1. Introduction

Robots have become more prominent in our lives in recent years and they take roles in settings such as therapy to entertainment. So, how they should be designed is an important issue to consider to receive the most benefit. A design aspect is their effect on our cognitive mechanisms, and in this study, we tackled attention. Previous literature has looked into how distractors affect us. With attention, we are able to ignore task-irrelevant stimuli; however, retaining focus depends on perceptual load (PL) [1, 2, 3, 4, 5, 6]. High PL makes us use full capacity whereas low PL leaves unused resources. With factors like uncanny valley [7], it is important to consider the human-likeness as it can affect the acceptance of an agent. Human-like agents may elicit negative responses. Hence, one can predict that agents producing negative feelings may distract us more, such as an android that looks almost human like.

The aim of the present study is to investigate whether robots distract our attention as much as humans do, and if so, what kind of robots do so and to what extent. To address this, we used a well-established paradigm in cognitive psychology developed by Lavie and her colleagues [5], which tests whether and how people process task-irrelevant (distractor) stimuli. We manipulated the distractor type, distractor presence, and PL. Our results indicate that humanoid robots distract us as much as humans but to what extent they do depends on our perceptual load.

2. Methods

2.1 Participants

22 students from Bilkent University (11 females, 11 males, Mean age = 23.09; SD = 4.19) participated in the study. Participants had normal or corrected-to-normal vision, and had no history of neurological disorders. The university's Human Ethics Committee approved the study and the participants gave informed consent accordingly.

2.2 Stimuli

The experiment includes two types of stimuli. The first one is the letter stimuli that are presented at the center of the screen as part of the central task (See *Design and Procedure*). The second type of stimuli were used as distractors and these consisted of pictures of three agents that vary in their human-likeness: a mechanical robot

(Robot), a human-like robot (Android), and a human (Human) (See Figure 1). They were used in a number of studies before [8-11].

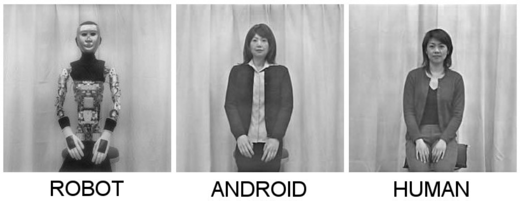

Figure 1: Task irrelevant stimuli in the experiment

2.3 Design and Procedure

There was an Easy Task and a Hard Task. In both, the subjects indicated whether they saw an X or an N by pressing the corresponding letter on a keyboard in a circle of six letters around the fixation. In the Easy Task, all the letters but the target letter were O; whereas in the Hard Task they were H,K,M,W,Z as used in [5]. The position of the target letter and the others were fully randomized. The order of the tasks was counterbalanced. There were 576 trials in total in each of the Easy Task and Hard Task. Half of the trials included a distractor and half did not. In trials where there was a distractor, the picture of one of the three agents (See Stimuli section) was presented on the left or right of the screen (8 degrees from the central fixation cross). The probability of the distractor appearing on the left or right of the screen was equal and fully randomized across trials. Subjects were instructed to ignore the peripheral stimuli and do the central, letter detection task. Each trial started with a fixation cross, presented at the center of the screen for 1 second. It was followed by the letter detection task. The letters were presented for 1 second and subjects were required to respond within this period. RT and accuracy were recorded.

2.4 Data Analysis

We conducted 2 (Task Difficulty: Easy, Hard) x 2 (Distractor: Absent, Present) repeated measures ANOVAs to investigate the effect of task difficulty and distractor both on RT and accuracy. In addition, we also conducted 2 (Task Difficulty: Easy, Hard) x 3 (Distractor type: Robot, Android, Human) repeated measures ANOVAs to investigate the effect of distractor type (agent type) and possible interaction with distractor type and task difficulty.

3. Results

3.1 Effect of Task Difficulty and Presence of Distractor

<u>*Reaction time*</u>: There was a main effect of task difficulty on RT. Subjects were overall significantly faster in detecting the target letter in Easy Task (Mean = 0.52 sec, SD = 0.05) than the Hard Task (Mean = 0.67 sec, SD = 0.07) (F(1,21) = 145.40, p<0.05). There was also a main effect of distractor on RT. Subjects detected the target letter significantly faster when there was no distractor (Mean = 0.58 sec, SD = 0.06) than when there was a distractor (Mean = 0.59, SD = 0.06) (F(1,21) = 12.29, p<0.05). There was no interaction between task difficulty and distractor (F(1,21) = 0.18, p=0.67).

<u>*Accuracy*</u>: There was a main effect of task difficulty on accuracy. Subjects were overall significantly more accurate in detecting the target letter in Easy Task (Mean = 96%, SD = 0.03) than the Hard Task (Mean = 81%, SD = 0.10) (F(1,21) = 46.84, p<0.05). There was not a main effect of distractor on accuracy (F(1,21) = 3.26, p=0.09). There was no interaction between task difficulty and distractor on accuracy (F(1,21) = 1.36, p=0.26).

3.2 Effect of Task Difficulty and Distractor Type

<u>*Reaction time:*</u> The results of the effect of task difficulty and distractor type on RT are shown in Figure 2A-B. There was a main effect of task difficulty on RT. Subjects were overall significantly faster in detecting the target letter in Easy Task (Mean = 0.52 sec, SD = 0.23) than the Hard Task (Mean = 0.67 sec, SD = 0.08) (F(1,21) = 136.59, p<0.05). There was not a main effect of_distractor type on RT (F(2,42) = 0.78, p=0.47). Therefore, there was insufficient evidence to suggest that the three agents distracted the subjects to different degrees. However, there was an interaction between task difficulty and distractor type (F(2,42) = 3.43, p<0.05). While subjects were distracted the most by Human and the least by Robot in Easy Task, the results were opposite in the Hard Task. Subjects were distracted the most by Robot, and the least by Human in the Hard Task.

<u>*Accuracy:*</u> There was a main effect of task difficulty on accuracy (Figure 2C-D). Subjects were overall significantly more accurate in detecting the target letter in Easy Task (Mean = 96%, SD = 0.03) than the Hard Task (Mean = 80%, SD = 0.11) (F(1,21) = 40.62, p<0.05). There was not a main effect of distractor type on accuracy (F(2,42) = 0.18, p=0.84). There was no interaction between task difficulty and distractor type on accuracy (F(2,42) = 1.91, p=0.16).

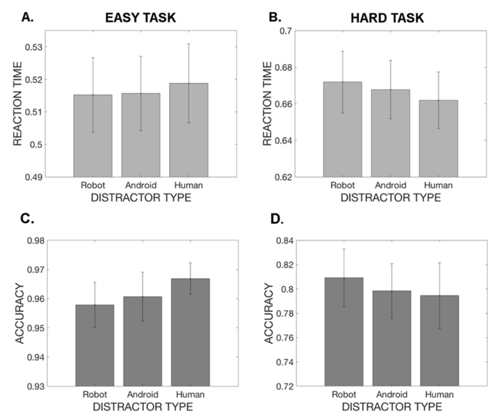

Figure 2: Reaction time (RT) (in seconds) and accuracy (percentage) with different types of task-irrelevant distractors.

4. Discussion

In conclusion, our study shows that humanoid robots can distract us as much as humans consistent with previous work. However, the present study extends previous work by showing that to what extent robots distract us depends on our perceptual load (PL) and the human-likeness of the robot. Our results show that when the main task is low PL, humans distract us more than robots. Furthermore, the more human-like a robot is, the more it distracts us. However, when the main task is high PL, the most distraction is from the least human-like agent (robot). We believe that our study sets as an example about how using robots with well-established paradigms in cognitive psychology can be fruitful and inform us both about robot design and human cognition.

REFERENCES

[1] N. Lavie, S. Cox (1997). On the efficiency of attentional selection: Efficient visual search results in inefficient rejection of distraction. Psychological Science, 8, 395-398.

[2] N. Lavie (2000). Selective attention and cognitive control: Dissociating attentional functions through different types of load. In Attention and performance, XVIII (S. Monsell, J. Driver (eds.)), pp. 175-194, MIT Press.

[3] N. Lavie, T. Ro, C. Russell (2003). The role of perceptual load in processing distractor faces. Psychological Science, 14 (5), 510-515.

[4] N. Lavie (2005). Distracted and confused? Selective attention under load. Trends in Cognitive Sciences, 9 (2), 75-82.

[5] S. Forster, N. Lavie (2008). Attentional capture by entirely irrelevant distractors. Visual Cognition, 16:2-3, 200-214.

[6] N. Lavie (2010). Attention, distraction, and cognitive control under load. Current Directions in Psychological Science, 19 (3), 143-148.

[7] M. Mori (1970). The uncanny valley. Energy, 7 (4), 33-35.

[8] A.P. Saygin, T. Chaminade, H. Ishiguro, J. Driver, C. Frith (2012). The thing that should not be: predictive coding and the uncanny valley in perceiving human and humanoid robot actions. Social Cognitive Affective Neuroscience, 7 (4), 413-422.

[9] B.A. Urgen, M. Kutas, A.P. Saygin (2018). Uncanny valley as a window into predictive processing in the social brain. Neuropsychologia, 114, 181-185.

[10] A.X. Li, M. Florendo, L.E. Miller, H. Ishiguro, A.P. Saygin (2015). Robot form and motion influences social attention. 10th ACM/IEEE International Conference on Human-Robot Interaction (HRI), Portland, USA.

[11] B.A. Urgen, S.Pehlivan, A.P.Saygin (2019). Distinct representations in occipito-temporal, parietal, and premotor cortex during action perception revealed by fMRI and computational modeling. Neuropsychologia, 127, 35-47.