The Effects of Appearance and Movement on the Attribution of Intelligence

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Abstract

This project expands on work by Morewedge, Preston, and Wegner (2007) and is intended to contribute to Carnegie Mellon University's Project on People and Robots, the purpose of which is to further knowledge regarding people's views on robots and robotic technologies. As advancements in robotics occur, it is important for us to understand how we perceive and relate to robots and other artificial agents. Studies have shown that our emotional response to robots depends upon their appearance and movements, but different researchers have developed contrasting opinions on the significance of appearance. When interacting with a robot, or watching an animated character, how do we gauge their behaviors to perceive them as showing signs of intelligence, or even sentience? At an early age, independent movement is undoubtedly the ability we learn that all living things possess. Studies by Morewedge, et al. (2007) show that the speed of movement impacts whether we deem an agent as having a mind. Subjects will view, in a balanced random order, movies of two different characters of three varying sizes moving at three different speeds. Afterward, they will answer a set of five questions designed to investigate the correlation between perception of movement and the attribution of intelligence to an animated character.

Keywords: perception, response, robots, animation, movement, intelligence, mind

I. Introduction

Robots and robotically-enhanced technologies are becoming increasingly prevalent in today's world. Consequently, it is of increasing significance that we come to a better understanding of how we relate to such non-human agents; new knowledge would benefit not only robotics, but also fields such as computer graphics, the applications of which range from animated features and video games to scientific simulations. However, the results of any such research would not be limited to being able to render more realistic animated figures or to create more socially acceptable robots—indeed, studies would enable us to answer important metaphysical questions. Features our cognitive faculties use to identify other humans, to discern whether a target has a mind, to determine what is *alive*, help us to key in on realities of nature.

It is established that watching other humans perform actions such as sitting, walking, and jumping activates a part of the brain known as the superior temporal sulcus (STS). However, the STS is not only stimulated when one views human motion, but rather any biological motion, suggesting the importance of movement over appearance [1]. Likewise, studies have shown that watching an action also activates the same regions of the brain involved in performing the action. These 'mirror neurons' contribute to the interference effect present when one attempts to perform an action contrary to the one being viewed. An experiment by Kilner, Paulignan, and Blakemore (2003) yielded that significant interference in movement occurred only when viewing incongruous motion performed by a human arm, versus a robotic one [2]. Subsequent work has shown that a humanoid robot was capable of producing interference in subject movement, although the effect was more pronounced when acting acting against biological, rather than artificial, motion [3]. Chaminade, et al. (2005) concluded that a mix of both form and motion might play into this.

How, then, would someone respond to something as decidedly non-human *and* non-humanoid as a blob? In [4], there seems to be a positive correlation between speed and intelligence, up to a certain extent. Mind is attributed to non-human targets that move at rates similar to a person; it is not just a matter of how quickly the target moves. Morewedge, et al. (2007) concluded that there exists a anthropocentric timescale bias, and that the relative speed of the target seems more significant than their absolute speed.

This study is designed to further investigate the aforementioned conclusion of [4], by pitting the walking and jumping motions of a blob against those of a man, using the well-known, established constant of acceleration due to gravity (9.8 m/s^2) and values just above and below the bounds of perceivably correct physical motion found by Reitsma and Pollard (2003) [5] (12.9 m/s^2 and 8.8 m/s^2, respectively), as well as three different factors of physical scaling (0.8529, 1.0, 1.1471) for the character models. Correct scaling of time was achieved using equations from Raibert and Hodgins' work on biped locomotion [6].

II. Methodology

Subjects
Besides posting on electronic bulletins, fliers designed to garner maximum interest will be dispersed and posted around Carnegie Mellon University's campus to attract subjects. A $5 Amazon.com gift card will also be used as an incentive for participation. Subjects will be screened to ensure even gender distribution, to meet minority quotas, and to avoid dealing with underage minors.

Movies
A total of 36 movies were created by modifying four original 3D animations: one of a 'normal'-sized man jumping, one of a 'normal'-sized blob (relative to the man; approximately half his height) jumping, and two of the man and blob walking, respectively. These original movies were created to be physically realistic, and the physical parameters of movement were identical for both the man and the blob—that is, each moved the same distance within same amount of time. Establishing the man's height to be 5'8", two new heights (each displaced 10" from normal height) were selected to establish scaling for 'small' and 'large' sizes: 4'10" and 6'6". The factors of scaling were 1.0, 0.8529, and 1.1471. Similarly, it was given that the original animations occurred in environments in which gravitational acceleration was 9.8 m/s^2, so two new constants outside of the range of perceivable physically correct motion (12.7 $m/s^2 < g <$ 9.0 m/s^2) [5] were selected: 8.8 m/s^2 and 12.9 m/s^2. Factors for scaling g were 1.0, 0.8980, and 1.3163. These parameters are summarized as follows:

Actions	jump	walk	---
Characters	blob	man	---
L_{man}	4'10"	5'8"	6'6"
L_{scale}	0.8529 'small'	1.0 'medium'	1.1471 'large'
g (in m/s^2)	8.8 'slow'	9.8 'correct'	12.9 'fast'
g_{scale}	0.8980	1.0	1.3163

Table 1: Variables and values used for creating permutations of the four original movies, including relative associations for size and speed.

To maintain physical correctness according to these new values, the times of the animations were scaled according to Table 1 in [6], yielding the following results:

Speed / Size	Small	Normal	Large
Slow	1.0553	0.9476	1.1302
Correct	0.9236	1.0	1.0710
Fast	0.8050	0.8716	0.9335

Table 2: Factors for scaling time according to the given parameters.

Surveys
After viewing each movie, the subject will be asked the five following questions in sequential order; valid responses are limited to a value from 1-5, with 3 being the normative midpoint for most of the questions:

1. How does this character's size compare to that of the average person?
   1 = smaller; 5 = larger
2. How does this character's speed compare to that of the average person?
   1 = slower; 5 = faster
3. How humanlike is this character's motion?
   1 = not humanlike; 5 = humanlike
4. How natural is this character's motion?
   1 = unnatural; 5 = natural
5. How intelligent does this character seem?
   1 = not intelligent; 5 = very intelligent

Subject responses are stored in a single file according to the number assigned to them, which is inputted at the beginning of the experiment. Both surveys and the playing of movies are executed through Perl scripts.

Experimental Design
There are currently two designs for this experiment. Design A (hereon referred to as EDA) utilizes 'play_all.pl' and begins the experiment and by playing a movie of the medium-correct man jumping, and then of him walking. This is followed by a balanced random order of all of the blob and man movies. Design B (EDB) requires 'play_set.pl,' which plays the jumping medium-correct man movie, followed by all of the jumping movies in a balanced random order. This, of course, is proceeded by the walking medium-correct man movie, and then randomly plays all of the walking movies. In both play scripts, after determining the order in which the movies are to be played, this information is written to a read-only file contained within a private subdirectory. All the movies are projected onto a single screen. The experiment begins by seating each subject at a computer and having them execute 'survey.pl,' after which they will be asked to input their subject number and made to wait for further instructions from the proctor. Excluding the two

control movies, at the end of each animation, the subject is instructed by the proctor to click the 'Respond' button and answer the five questions. As each movie is between one- to three- seconds long, the total time required for this experiment should be no longer than 30 minutes.

III. Current Status

Completed Tasks
All prep work—e.g., movie files and scripts—for experimental testing is complete and ready for use.

Remaining Tasks
An experimental design needs to be selected, as does a better algorithm for more balanced randomization of movie files. The script will be easy to edit; only the randomize() subroutine will need to be rewritten. If the proctor/subject setup proves to be too difficult to implement, the scripts 'survey1.pl' and 'survey2.pl' may be utilized for EDA or EDB, respectively. After testing, data analysis will be necessary, and a conclusion formed. Finally, the results of this work will require contemplation of ideas for future research.

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