

Disappearance of Inversion Effect for Walking Animation with Robotic Appearance

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Abstract

Recent studies have reported similarity in the neural processing of human and robot actions; however, whether this is the case remains controversial. Here, we examined this controversy using the inversion effect, a phenomenon whereby an upright face- and body-sensitive event-related potential component is enhanced and delayed in response to an inverted face and body, but not an inverted object. The results showed that the inversion effect occurs only with a human, not with robotic and point-light appearances, suggesting that our visual system differentially processes human and robot actions.

Introduction

It has been suggested that our neural system is tuned specifically to be able to detect the human face, body and human movements (e.g. Downing et al., 2001; Gauthier et al., 2000; Kanwisher, 2000; Grossman et al., 2000).

With the recent development of robotic technologies, robots with a very human-like appearance are now being developed, and at a glance, are often indistinguishable from human beings¹.

Since these robots have similar appearance information to humans, such as body structure and configuration, yet are not a biological object, the question therefore arises as to whether or not our neural system interprets such robots as a kind of human. To date, several studies have provided clues to this question (e.g. Kilner et al., 2003; Pelphrey et al. 2003)

The aim of the present study is to clarify how different appearance information with identical motion information affects the neural response. To investigate this, we recorded event-related potentials (ERPs) in human participants and evaluated the occurrence of the inversion effect (e.g. Stekelenburg & de Gelder, 2004). The inversion effect is a phenomenon whereby an upright face- and body-sensitive ERP component (N170) is delayed (e.g. Bentin et al., 1996) and enlarged in amplitude (e.g. Linkenkaer-Hansen et al., 1998) in response to inverted faces and bodies but not inverted objects (e.g. Rossion et al., 2000).

In this study, we employed three kinds of walking animation with different superficial information (human, robot and point-light appearance) to explore above question.

Materials and Methods

Three kinds of walking animation (Fig. 1) (human, robot and point-light) with two orientations (upright and inverted) were employed. The structure of the body and walking speed were identical in all animations. The duration of each animation was 510 msec. Nineteen healthy participants were included as study participants. They were required to view each animation passively and mentally count the number of asterisks appearing randomly during each block. Electroencephalograms (EEGs) were recorded during each trial with a Geodesic Sensor Net composed of 64 electrodes.

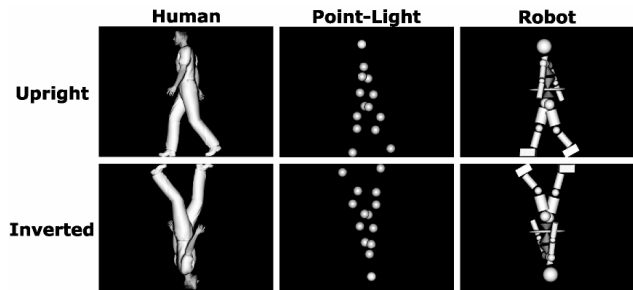


Figure 1: The experimental stimuli. All animations were viewed in profile as walking as if on a treadmill.

Results

Fig.2A shows the grand mean waveforms of the ERP responses. As in our previous study (Hirai et al., 2005), we collapsed the three electrodes surrounding each T5/T6 (International 10-20 System) into two sites. A single negative peak was found at around 200 ms (conventional N170-like component) in both the human and robot conditions, while in the point-light condition two negative peaks were observed at 200 and 340 ms, respectively. The peak latency and amplitude (in order to correct the N1 amplitude, we calculated the P1-N1 amplitude) of each component were also calculated, and subsequently, statistical analysis was carried out.

Fig.2B shows the distributions of the difference in ERP amplitudes (the ERP amplitude in the upright condition minus that in the inverted condition) with each appearance condition. At 200-248 ms, the topographic pattern with the human condition was clearly different from that with both the point-light and robot conditions.

¹ <http://news.bbc.co.uk/1/hi/sci/tech/4714135.stm>

P1-N1 amplitude and N1 latency In three-way ANOVA of the P1-N1 amplitude, laterality \times type of appearance \times orientation was significant [$F(2,36) = 3.37, p < 0.05$]. Subsequent analysis revealed that the amplitude in the right hemisphere was significantly larger with the inverted orientation than the upright orientation in the human appearance condition [$4.24\mu\text{V}$ vs. $5.18\mu\text{V}$, $F(1,108) = 9.62, p < 0.01$]. The main effect of orientation was also significant with the N1 latency, [$F(1,18) = 4.72, p < 0.05$; upright: 218.6ms vs. inverted: 224.0ms], indicating that the latency of inverted stimuli was longer than that of upright stimuli.

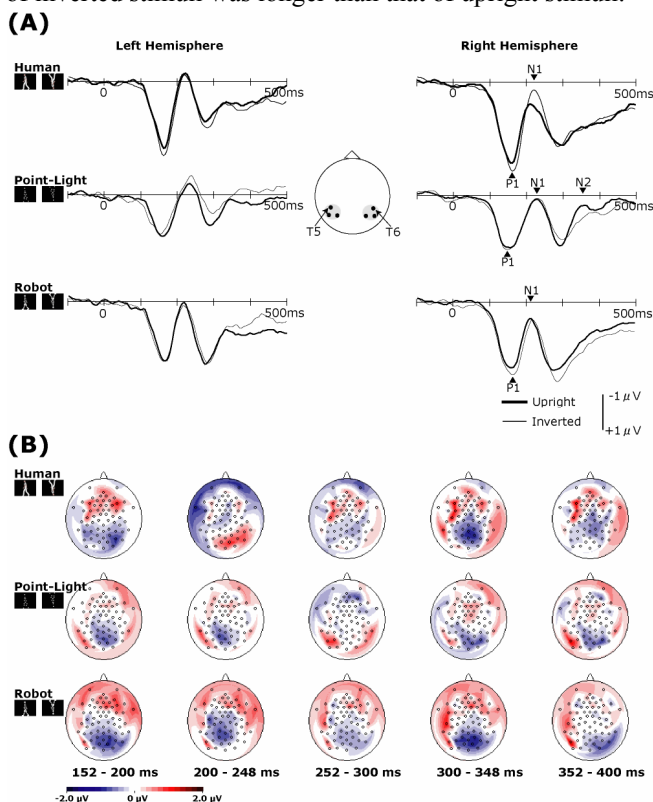


Figure 2: (A) Grand averaged ERP waveforms showing the inversion effect with each appearance and orientation condition. (B) Distributions of the difference in ERP amplitudes (the ERP amplitude in the upright condition minus that in the inverted condition) with each appearance condition.

Conclusion and Discussion

Our data demonstrated that the inversion effect occurs in the right occipitotemporal region with the human appearance condition only. These findings are consistent with the results of recent neuroimaging studies of face and body perception (e.g. Bentin et al., 1996). With regard to latency, a recent study suggested that the delay in latency of the N1 component is observed not only with faces but also objects (Itier et al., 2006), which is also consistent with our present data. The present findings imply that robot walking animation is not processed like human information (i.e. robots are not categorized as humans), even though the robots are analogous in appearance and have identical motion properties (speed and motion trajectory). This

suggests that appearance information affects the neural responses and this categorization is processed within early visual processing.

Acknowledgments

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