Research Article

THE BODY-INVERSION EFFECT

Catherine L. Reed,[1] Valerie E. Stone,[1] Senia Bozova,[1] and James Tanaka[2]
[1]*University of Denver and* [2]*Oberlin College*

Abstract—*Researchers argue that faces are recognized via the configuration of their parts. An important behavioral finding supporting this claim is the face-inversion effect, in which inversion impairs recognition of faces more than nonface objects. Until recently, faces were the only class of objects producing the inversion effect for untrained individuals. This study investigated whether the inversion effect extends to human body positions, a class of objects whose exemplars are structurally similar to each other. Three experiments compared the recognition of upright and inverted faces, houses, and body positions using a forced-choice, same/different paradigm. For both reaction time and error data, the recognition of possible human body postures was more affected by inversion than the recognition of houses. Further, the recognition of possible human body postures and recognition of faces showed similar effects of inversion. The inversion effect was diminished for impossible body positions that violated the biomechanical constraints of human bodies. These data suggest that human body positions, like faces, may be processed configurally by untrained viewers.*

Many researchers have proposed that faces are a unique class of objects because they are recognized using processes different from those used to recognize most other objects. However, some differences between face and object processing thought to support the uniqueness of face processing have been found to apply to nonface objects (e.g., dogs, birds, computer-generated "Greebles") when they either have special properties or are viewed by expert viewers (Carey, 1992; Diamond & Carey, 1986; Gauthier & Tarr, 1997; Rhodes, Tan, Brake, & Taylor, 1989; see Tanaka & Gauthier, 1997, for review). Thus, the visual system may process faces differently because faces have certain abstract properties. These properties may be shared by some other nonface objects. However, researchers are far from resolution on what properties or objects evoke distinctive recognition processing. One class of objects that shares several abstract properties with faces is human body position. Like faces, bodies allow people to recognize conspecifics and convey information about identity, age, gender, intentions, and emotional state. They also have a distinctive set of parts that can vary in their configuration. The purpose of the study we report here was to investigate whether the special processing used in face recognition extends to this novel class of objects that shares some essential social and physical properties with faces.

One piece of evidence for special recognition processes is the inversion effect in object recognition. Although most objects are somewhat more difficult to recognize upside down than right side up, inversion disproportionately disrupts the recognition of faces relative to the recognition of most other objects (e.g., houses, landscapes; Carey, 1992; Scapinello & Yarmey, 1970; Yarmey, 1971; Yin, 1969). In other words, faces, more than other objects, are recognized most quickly and accurately in their upright position. The inversion effect for faces has proven to be one of the most robust phenomena in the face-recognition literature (Carey & Diamond, 1994; Diamond & Carey, 1986; Yin, 1969); however, subsequent studies have revealed that under certain conditions, inversion can also disrupt the recognition of other, nonface stimuli (e.g., de Gelder & Rouw, 2000b; Diamond & Carey, 1986; Gauthier & Tarr, 1997).

The face-inversion effect has been attributed to a disruption of configural processing (e.g., Bruce, Doyle, Dench, & Burton, 1991; Carey, 1992; Farah, Tanaka, & Drain, 1995; Freire, Lee, & Symons, 2000). What separates the recognition of faces from that of other objects may be the importance of the specific configuration of facial features. This configuration is disrupted when a face is inverted (Carey, 1992; Leder & Bruce, 2000). Neuroimaging shows that inversion disrupts the normal processing of faces. Inverted faces activate brain regions that are different from those activated by upright faces and similar to those activated by nonface objects (Haxby et al., 1999). It may be that inversion effects are found for any class of objects for which recognition depends on specific configurations of parts.

In the present experiments, we investigated whether the recognition of human body postures is susceptible to an inversion effect. Bodies and faces share many stimulus properties: configuration, level of categorization, and frequency of occurrence leading to expertise in human viewers. Human bodies are highly symmetric in part organization. They share the same set of parts (e.g., arms, legs, trunk, head) and require people to make fine distinctions based on the shape and size of these parts. Exemplars of body positions are distinguished by subtle differences in the spatial relations among parts and are recognized at the subordinate level. People should have expertise in body-position recognition, as they do in face recognition, because they experience bodies as frequently as faces—people rarely see a face without a body attached (and when they do, recognition is not their major concern!). Although the body is a rich source of information, comparatively little research on processes underlying body recognition has been conducted (e.g., Aguirre, Singh, & D'Esposito, 1999). Evidence for body-specific processing comes from single-cell (e.g., Wachsmuth, Oram, & Perrett, 1994), neuroimaging (Downing, Jiang, Shuman, & Kanwisher, 2001), neuropsychological (e.g., Ogden, 1985), and behavioral studies (e.g., Reed & Farah, 1995; Shiffrar & Freyd, 1993).

Further, there is reason to expect an inversion effect for bodies. In point-light-walker displays, observers see points of light located on the joints of a moving body and are able to differentiate friends and identify various actions. However, this recognition is disrupted when the displays are upside down (Bertenthal, Proffitt, & Kramer, 1987; Kozlowski & Cutting, 1977; Pavlova & Sokolov, 2000).

In three experiments, we compared the processing of body postures with that of faces, houses, and biomechanically impossible body postures by using a forced-choice, same/different recognition paradigm for upright and inverted stimuli. For nonhuman objects, we chose houses because they are a class of objects that do not appear to be significantly affected by inversion (Tanaka & Farah, 1993; Tanaka & Sengco, 1997). In this way, we determined whether bodies, like faces and unlike houses, produce an inversion effect. The examination of

Address correspondence to Catherine L. Reed, Department of Psychology, University of Denver, 2155 S. Race St., Denver, CO 80208; e-mail: creed@du.edu.

impossible body postures speaks to the contribution of specific spatial relationships among body parts to the body-inversion effect.

EXPERIMENT 1

In Experiment 1, we investigated whether the recognition of human body position is affected by inversion. We compared human body stimuli with house stimuli in a classic inversion paradigm (e.g., de Gelder & Rouw, 2000a, 2000b). Previous studies have found that houses are less susceptible to an inversion effect than faces, suggesting that their recognition depends more on features than on configurations (e.g., Tanaka & Farah, 1993). If human body positions are processed by the configuration of their parts, then an inversion effect should be found for bodies, but not for houses.

Method

Participants

Seventeen University of Denver undergraduates participated for extra credit in psychology courses. In this and the subsequent experiments, participants had normal or corrected-to-normal vision.

Stimuli

The body stimuli were three-dimensional male and female figures created using Fractal Design Poser 2.0™. They measured approximately 14 cm × 10 cm. Each figure's arms and legs were positioned to create novel poses that were visually distinguishable from each other, had no meaning, and could not be easily labeled. The poses were asymmetrical with respect to both vertical and horizontal axes. All poses were physically possible. A distractor was constructed for each figure by altering the position of one or two body parts: An arm, a leg, or the head of the figure was placed at a different angle or in a different position. After preliminary testing for comparable discriminability, 16 body-stimulus pairs, half male and half female, were selected. An example of a pair is shown in Figure 1a.

The house stimuli were three-dimensional line drawings created on a Macintosh computer using an architectural design software package (see Tanaka & Farah, 1993). The houses were approximately 12 cm high and 17 cm wide. The house distractor stimuli were created using a criterion similar to that used for the body stimuli. The position or shape of one or two of the following elements was altered: the door, steps, chimney, main window, or small window. To make the discrimination difficulty of the house stimuli comparable to that of the body

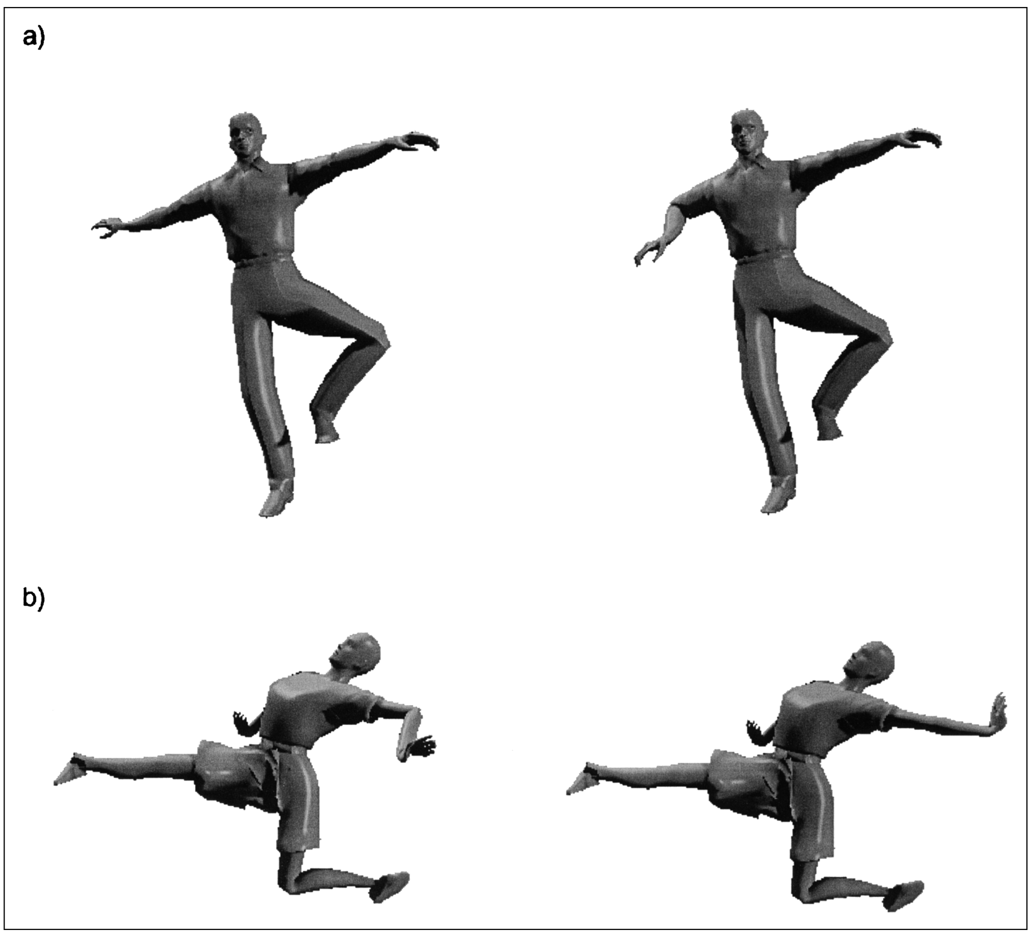

Fig. 1. Examples of the (a) possible (Experiments 1–3) and (b) impossible (Experiment 3) body-position stimuli used in the experiments. The correct response for the top pair is "same," and the correct response for the bottom pair is "different."

stimuli (10–20% error rate), we conducted preliminary testing and then selected 16 pairs of houses.

Procedure

Each participant was seated 70 cm from a 13-in. Macintosh computer monitor. Chair height was adjusted so that the participant's eyes were level with the center of the computer screen. The participant was instructed that the experiment had two parts: In one part, the task was to determine whether two houses were the same or different; in the other part, the task was to determine whether two body positions were the same or different. On each trial for both types of stimuli, the first stimulus was presented for 250 ms, followed by a blank screen for 1,000 ms, and then a second stimulus appeared until the participant responded. Participants pressed the "S" key using their left index finger if the two stimuli were the same and the "L" key using their right index finger if the stimuli were different. The "S" and "L" keys were labeled with "S" and "D" stickers, indicating "same" and "different," respectively. For all trials, participants were asked to respond as fast and accurately as possible. Response time (RT) and accuracy were recorded.

House stimuli and body stimuli were presented in separate blocks, with block order counterbalanced across participants. Each of the two blocks contained 192 trials, for a total of 384 trials. Each stimulus pair was presented 12 times, 6 times in an upright orientation and 6 times in an inverted, or 180°, orientation. On half of the trials the two stimuli were the same, and on half they were different. Each block started with 2 practice trials, one "same" and one "different," that contained stimuli not included in the experimental block. The entire testing session lasted approximately 45 min.

Results and Discussion

For each participant, mean proportion error and RT were calculated for each condition. For RT data, we analyzed only trials for which the response was correct. Two participants were eliminated from the analyses, 1 because his overall error rate was greater than 40% and 1 because his RTs were 3 *SD* greater than the mean of the other subjects. Thus, the data from 15 participants are included in the analyses reported here. Preliminary analyses revealed no main effect or interactions for block order, and it is not a factor in the following analyses.

A repeated measures Object (bodies, houses) × Orientation (upright, inverted) analysis of variance (ANOVA) was conducted on the error data. The interaction between object and orientation was significant, $F(1, 14) = 10.92$, $MSE = 0.00065$, $p < .005$. Participants were more likely to make errors recognizing inverted than upright body postures, $F(1, 14) = 34.80$, $MSE = 0.0015$, $p < .0001$, but this difference was not found for houses, $F(1, 14) < 1$, n.s. This interaction is illustrated in the top panel of Figure 2. Despite pretesting, an object effect was found, $F(1, 14) = 10.80$, $MSE = 0.0051$, $p < .005$, indicating that houses were more difficult than bodies to discriminate. An orientation effect, $F(1, 14) = 9.37$, $MSE = 0.0008$, $p < .008$, indicated a main effect of inversion.

A repeated measures Object (bodies, houses) × Orientation (upright, inverted) ANOVA on the RT data yielded a significant interaction between object and orientation, $F(1, 14) = 7.09$, $MSE = 549.02$, $p < .019$. Participants were slower to recognize inverted than upright body postures, $F(1, 14) = 30.81$, $MSE = 1{,}506.34$, $p < .0001$, but this difference was not found for houses, $F(1, 14) < 1$, n.s. This interaction is illustrated in the bottom panel of Figure 2. An object effect was found, $F(1, 14) = 7.78$, $MSE = 9{,}898.84$, $p < .015$, indicating that houses took longer to discriminate than bodies. The orientation effect, $F(1, 14) = 9.49$, $MSE = 989.52$, $p < .008$, indicated a main effect of inversion.

In summary, in both the error and the RT data, an inversion effect was found for bodies but not houses. These results support the prediction that inversion influences the recognition of body postures more than the recognition of houses. The lack of an inversion effect for houses replicated the findings of Tanaka and Farah (1993), who used similar stimuli.

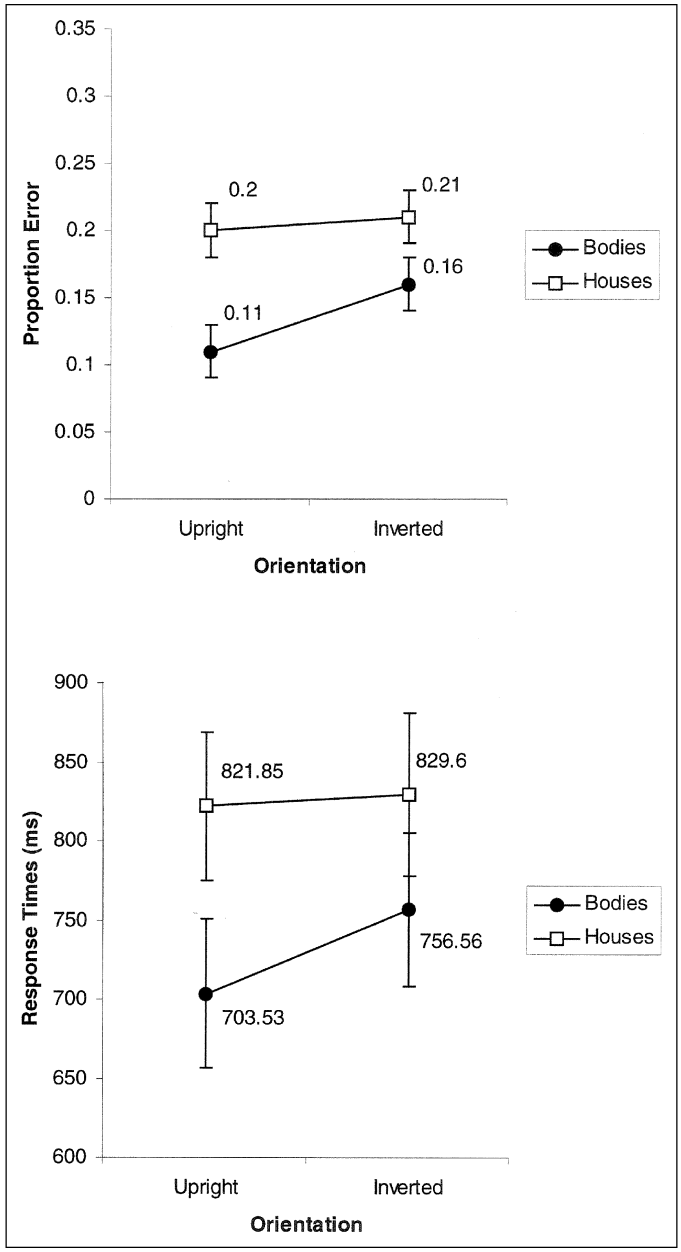

Fig. 2. Proportion error (top panel) and mean response time (bottom panel; correct trials only) for upright and inverted body-position and house stimuli in Experiment 1.

EXPERIMENT 2

In Experiment 2, we investigated whether an inversion effect would be found for both bodies and faces. This result would suggest that both are processed configurally.

Method

Participants

Eighteen University of Denver undergraduates participated for extra credit in psychology courses.

Stimuli

The same body stimuli from Experiment 1 were used. The face stimuli were black-and-white photographs of bald male and female Caucasian, African American, and Asian faces. The faces measured approximately 8 cm × 9 cm. Distractor stimuli were selected from the same set of photographs. Each distractor stimulus matched the stimulus with which it was paired in both gender and ethnicity, but differed on one or two features, such as facial hair. After preliminary testing, we selected a set of 16 face pairs that was comparable in discrimination difficulty to the upright body stimuli (10–20% error).

Procedure

The procedure was the same as in Experiment 1.

Results and Discussion

For each participant, the mean error rate and RT were calculated for each condition. For RT, we analyzed data from trials with correct responses only. Preliminary analyses revealed no main effect or interactions for block order; it is not a factor in the following analyses.

A repeated measures Object (bodies, faces) × Orientation (upright, inverted) ANOVA was conducted on the error data. The orientation effect, $F(1, 17) = 109.44$, $MSE = 0.0034$, $p < .0001$, indicated a main effect of inversion. The object effect was not significant, $F(1, 17) = 3.22$, $p = .09$, indicating that face and body stimuli were of comparable discriminability. The interaction between object and orientation was not significant, $F(1, 17) = 1.76$, $p < .21$. Similar inversion effects were found for faces and bodies (Fig. 3, top panel). Planned comparisons confirmed inversion effects for both face stimuli, $F(1, 17) = 67.63$, $MSE = 0.0024$, $p < .0001$, and body stimuli, $F(1, 17) = 19.65$, $MSE = 0.0012$, $p < .0001$.

A repeated measures Object (bodies, faces) × Orientation (upright, inverted) ANOVA was conducted for the RT data. The orientation main effect, $F(1, 17) = 56.03$, $MSE = 6{,}381.96$, $p < .0001$, indicated an effect of inversion. No object effect was found, $F(1, 17) < 1$, n.s., indicating that face and body stimuli were equally discriminable. No interaction between object and orientation was found, $F(1, 17) < 1$, n.s. (Fig. 3, bottom panel). Planned comparisons confirmed inversion effects for both face stimuli, $F(1, 17) = 32.72$, $MSE = 2{,}694.51$, $p < .0001$, and body stimuli, $F(1, 17)= 21.06$, $MSE = 3{,}729.40$, $p < .0001$.

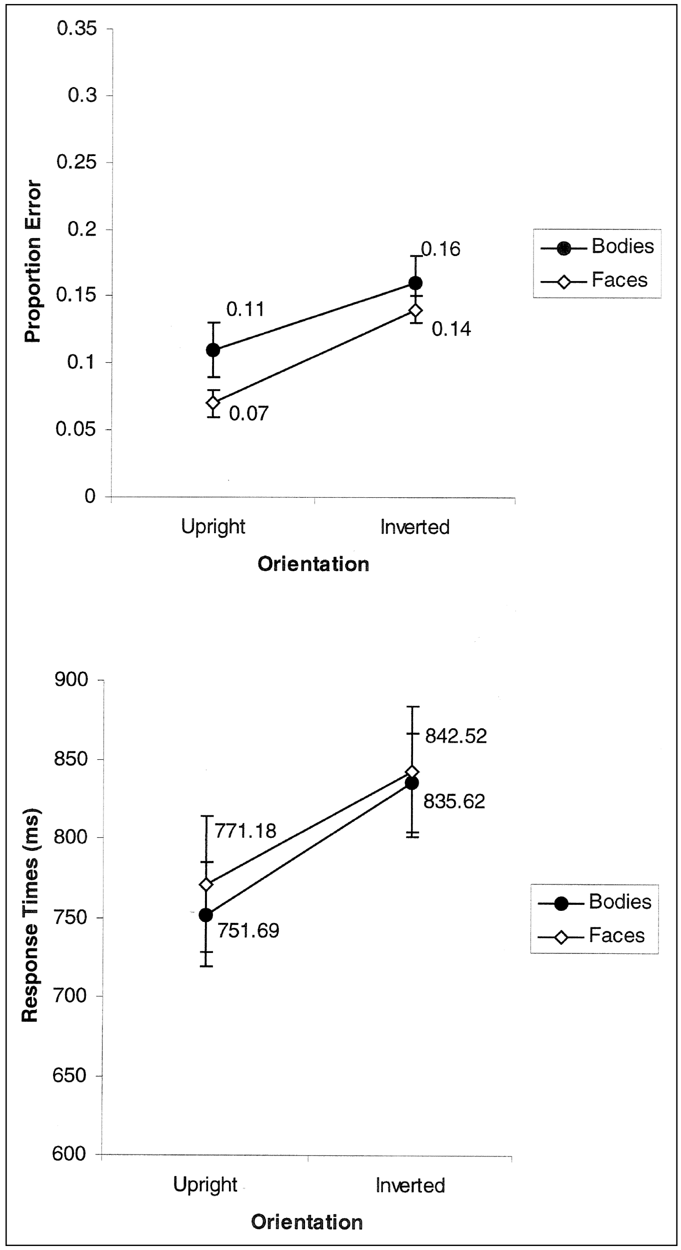

Fig. 3. Proportion error (top panel) and mean response time (bottom panel; correct trials only) for upright and inverted body-position and face stimuli in Experiment 2.

In summary, inversion disrupts the recognition of both body positions and faces. These results suggest that configural processing may be important for the recognition of both types of stimuli.

EXPERIMENT 3

In Experiment 3, we investigated whether the body-inversion effect indicates a disruption of configural processing by comparing two types of body configuration: biomechanically *possible* and biomechanically *impossible* body positions. For impossible body positions, we altered normal body configuration by placing a particular body part at an angle outside of the body's degrees of freedom for motion. Just as people have experience with the particular spatial configuration of facial features that real faces share, they have experience with particular configurations of body parts. When presented with an unfamiliar (i.e., physically impossible) configuration of body parts, participants may rely less on configural processing, thereby leading to a reduction in the body-inversion effect.

Method

Participants

Thirty-five students from the University of Denver participated for extra credit in psychology courses.

Stimuli

For the possible body positions, we used the same abstract body poses used in Experiments 1 and 2, plus an additional set of four pairs.

We created 20 impossible body poses using Fractal Design Poser 2.0™. In each impossible pose, at least three joints were placed in positions that could not be assumed by the typical degrees of freedom for those joints. Joints were defined as the junctures of the arms and legs, the neck, and the bending points of the torso, including the waist, chest, and pelvis. The remaining limb positions were placed in physically possible locations. The distractor for each impossible figure was constructed by starting with the initial figure and placing one of its limbs at a different angle or in a different position. An example of a stimulus and its distractor is shown in Figure 1b.

Procedure

The procedure was the same as in Experiments 1 and 2.

Results and Discussion

For each participant, mean error and RT were calculated for each condition. Three participants were eliminated, 1 for having an error rate greater than 40%, 1 for not completing the entire experiment, and 1 for having a majority of RTs less than 50 ms. Thus, the data from 32 participants are included in the analyses here.

A repeated measures Object (possible positions, impossible positions) × Orientation (upright, inverted) ANOVA was conducted for the error data. Main effects were found for orientation, $F(1, 31) = 15.38$, $MSE = 0.0010$, $p < .001$, and for object, $F(1, 31) = 28.91$, $MSE = 0.0011$, $p < .001$. The interaction was not significant, $F(1, 31) < 1$, n.s. Post hoc analyses showed that participants were more likely to make errors for inverted than for upright body postures, whether impossible, $F(1, 31) = 10.12$, $MSE = 0.0005$, $p < .003$, or possible, $F(1, 31) = 10.61$, $MSE = 0.0005$, $p < .003$ (Fig. 4, top panel).

A repeated measures Object (possible positions, impossible positions) × Orientation (upright, inverted) ANOVA was conducted for the RT data. Main effects were found for orientation, $F(1, 31) = 8.01$, $MSE = 1{,}034.76$, $p < .01$, and object, $F(1, 31) = 14.89$, $MSE = 728.79$, $p < .001$. However, unlike for the error data, the Object × Orientation interaction was significant, $F(1, 31) = 7.27$, $MSE = 176.46$, $p < .011$. Post hoc analyses showed that participants were not significantly slower to recognize inverted than upright impossible poses, $F(1, 31) = 2.71$, $MSE = 178.30$, $p < .11$, but were slower to recognize inverted than upright possible poses, $F(1, 31) = 11.79$, $MSE = 1{,}032.92$, $p < .002$ (Fig. 4, bottom panel).

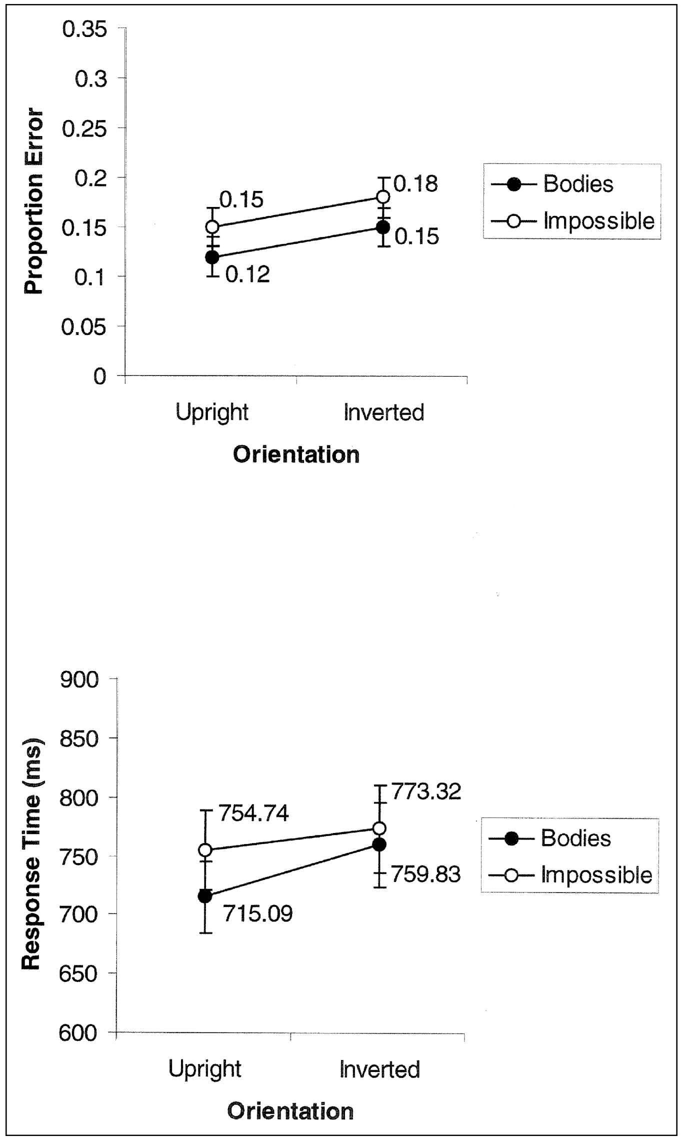

Fig. 4. Proportion error data (top panel) and mean response time (bottom panel; correct trials only) for upright and inverted possible and impossible body-position stimuli in Experiment 3.

In sum, the body-inversion effect is diminished when the normal biological configuration of body parts is compromised. Impossible body poses appear to be processed less configurally than possible body poses. These results imply that specific spatial relationships, or configurations, are important for the visual processing of body postures and that inversion disrupts this type of processing.

GENERAL DISCUSSION

The purpose of this study was to investigate whether an empirical phenomenon once thought to indicate face-specific processing, the inversion effect, might also extend to processing of human body positions. Inversion effects have been proposed to be indicators of configural processing (Carey & Diamond, 1994; Freire et al., 2000; Rhodes, Brake, & Atkinson, 1993; Tanaka & Sengco, 1997; Young, Hellawell, & Hay, 1987). Although no inversion effects have been found for nonface stimuli such as flowers, houses, and landscapes, more recent work has demonstrated that other nonface objects can produce inversion effects if viewers have sufficient expertise (see Tanaka & Gauthier, 1997, for review). However, until now, faces were the only class of stimuli to produce significant inversion effects for the *untrained* viewer.

This report presents the first evidence of a strong inversion effect for human body positions. Using a forced-choice, same/different, inversion paradigm, we examined inversion effects for three sets of common, mono-oriented objects: body positions, faces, and houses. We found that bodies were processed faster and more accurately when upright than when inverted. Previous findings that faces also produced an inversion effect, but houses did not, were replicated. Furthermore, the inversion effect for body postures was diminished when the biomechanical constraints of body positions were violated. The data suggest that human body positions may be processed configurally by most viewers.

One argument for why faces show an inversion effect is that people are experts at recognizing the specific configurations of features that distinguish individual faces and that inversion disrupts the configuration at which people are expert. In order to be competent members of any social group, people must become "face experts" (Carey, 1992). People are thought to be face experts to the degree that they can differentiate a particular face according to its configural properties (Carey, 1992). Even within the face-processing domain, expert specialization can be found in that people have an advantage for recognizing faces within their own race as opposed to other-race faces (Bothwell, Brigham, & Malpass, 1989; Chance & Goldstein, 1996; Lindsay, Jack, & Christian, 1991). This advantage is eliminated when faces are inverted (Rhodes et al., 1989).

In general, familiarity and expertise with particular classes of objects influence object recognition by developing an increased ability to use configural information. Perceptual experts such as bird-watchers and dog judges can recognize individuals in a particular class more quickly and accurately than nonexperts can (Tanaka & Taylor, 1991). In addition, expert dog breeders and bird-watchers are susceptible to inversion effects when recognizing silhouettes of dogs and birds, respectively (Carey, 1992; Diamond & Carey, 1986). Gauthier, Tarr, and their colleagues demonstrated an inversion effect for Greebles, artificial objects that have the same basic features arranged in a common prototypical configuration (Gauthier & Tarr, 1997; Gauthier, Williams, Tarr, & Tanaka, 1998). In these studies, participants were trained to become experts in Greeble recognition. The critical finding was that as participants achieved expert levels of performance, their configural processing improved, as did their susceptibility to inversion effects. However, the improved performance and the inversion effect are found only after extensive explicit training with the specific items tested (see also Biederman & Kalocsai, 1997).

Diamond and Carey (1986) proposed that inversion effects depend on two preexisting conditions. First, exemplars of the object class must share a prototypical configuration by which individual exemplars are distinguished (i.e., second-order relational properties). Inversion disrupts the second-order, or configural, properties needed to differentiate individual exemplars. Evidence to support the link between configural processing and face inversion comes from paradigms that examine configural recognition of composite faces (Young et al., 1987), face parts (Tanaka & Farah, 1993; Tanaka & Sengco, 1997), and faces varying in either configuration or features (Freire et al., 2000). The second criterion Diamond and Carey (1986) proposed for inversion effects was that participants must have sufficient exposure, practice, and ability to differentiate objects on the basis of their second-order relational properties. Empirically, inversion effects are obtained only when the observer has the necessary expertise to differentiate objects on the basis of their configural properties.

Human body positions appear to meet both criteria in Diamond and Carey's (1986) theoretical framework. Like human faces, human bodies are composed of a set of common parts (e.g., two arms, two legs, a trunk) that are arranged in a prototypical configuration (e.g., the two arms are located in the upper half of the trunk and legs are located in the lower half). Furthermore, body postures and faces are both identified at the individual exemplar level, and both may require configural information to be recognized at this level. For example, individuals are skilled in their ability to recognize actions or meaningful postures on the basis of body configuration (Kozlowski & Cutting, 1977).

Thus, our results demonstrating an inversion effect for body postures speak to the abstract properties of stimuli that evoke differential, or configural, processing by the visual system. Why might configural processing be important for faces and body positions when it appears to be less important for many other objects? A configural processing approach may be best suited for objects that people encounter frequently, that share a high degree of structural similarity (i.e., have small distinctions between objects in the class), and that require quick and accurate expert recognition (Gauthier & Tarr, 1997; Gauthier et al., 1998).

Though our data illuminate some factors that can lead to inversion effects, they do not address whether the same or similar processes are used for the recognition of faces and body postures. It is possible that although both faces and body postures produce inversion effects, they are recognized using different configural processing algorithms in the visual system. Further studies are needed to clarify how specific types of configural processing are used for body-position recognition and face recognition.

Inversion effects are indicative of configural processing, but by themselves do not definitively demonstrate that a class of objects is processed configurally. Stronger evidence that body postures are processed configurally comes from Experiment 3, in which we found that manipulating whether a position was biomechanically possible or not changed the inversion effect. Biomechanically impossible positions are further from any prototypical body position than possible positions are, and show a reduced inversion effect, a finding that is consistent with Diamond and Carey's (1986) framework. Not only is the configuration in an impossible body position different from any prototype, but also people necessarily have less expertise with impossible than possible positions. The three experiments taken together provide evidence that body positions are processed configurally by the untrained viewer.

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REFERENCES

Aguirre, G.K., Singh, R., & D'Esposito, M. (1999). Stimulus inversion and the responses of face and object-sensitive cortical areas. *NeuroReport*, *10*, 189–194.

Bertenthal, B.I., Proffitt, D.R., & Kramer, S.J. (1987). Perception of biomechanical motions by infants: Implementation of various processing constraints. *Journal of Experimental Psychology: Human Perception and Performance*, *13*, 577–585.

Biederman, I., & Kalocsai, P. (1997). Neurocomputational bases of object and face recognition. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, *352*, 1203–1219.

Bothwell, R.K., Brigham, J.C., & Malpass, R.S. (1989). Cross-racial identifications. *Personality and Social Psychology Bulletin*, *15*, 19–25.

Bruce, V., Doyle, T., Dench, N., & Burton, M. (1991). Remembering facial configurations. *Cognition*, *38*, 109–144.

Carey, S. (1992). Becoming a face expert. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, *335*, 95–103.

Carey, S., & Diamond, R. (1994). Are faces perceived as configurations more by adults than by children? *Visual Cognition*, *1*, 253–274.

Chance, J.E., & Goldstein, A.G. (1996). The other-race effect and eyewitness identification. In S.L. Sporer, R.S. Malpass, & G. Koehnken (Eds.), *Psychological issues in eyewitness identification* (pp. 153–176). Mahwah, NJ: Erlbaum.

de Gelder, B., & Rouw, R. (2000a). Configural face processes in acquired and developmental prosopagnosia: Evidence for two separate face systems? *NeuroReport*, *11*, 3145–3150.

de Gelder, B., & Rouw, R. (2000b). Paradoxical configuration effects for faces and objects in prosopagnosia. *Neuropsychologia*, *38*, 1271–1279.

Diamond, R., & Carey, S. (1986). Why faces are and are not special: An effect of expertise. *Journal of Experimental Psychology: General*, *115*, 107–117.

Downing, P., Jiang, Y., Shuman, M., & Kanwisher, N. (2001). A cortical area selective for visual processing of the human body. *Science*, *293*, 2470–2473.

Farah, M.J., Tanaka, J.W., & Drain, H.M. (1995). What causes the face inversion effect? *Journal of Experimental Psychology: Human Perception and Performance*, *21*, 628–634.

Freire, A., Lee, K., & Symons, L.A. (2000). The face-inversion effect as a deficit in the encoding of configural information: Direct evidence. *Perception*, *29*, 159–170.

Gauthier, I., & Tarr, M.J. (1997). Becoming a ‘Greeble’ expert: Exploring the face recognition mechanism. *Vision Research*, *37*, 1673–1682.

Gauthier, I., Williams, P., Tarr, M.J., & Tanaka, J.W. (1998). Training “Greeble” experts: A framework for studying expert object recognition processes. *Vision Research*, *38*, 2401–2428.

Haxby, J.V., Ungerleider, L.G., Clark, V.P., Schouten, J.L., Hoffman, E.A., & Martin, A. (1999). The effect of face inversion on activity in human neural systems for face and object perception. *Neuron*, *22*, 189–199.

Kozlowski, L.T., & Cutting, J.E. (1977). Recognizing the sex of a walker from a dynamic point-light display. *Perception & Psychophysics*, *21*, 575–580.

Leder, H., & Bruce, V. (2000). When inverted faces are recognized: The role of configural information in face recognition. *Quarterly Journal of Experimental Psychology*, *53A*, 513–536.

Lindsay, D.S., Jack, P.C., & Christian, M.A. (1991). Other-race face perception. *Journal of Applied Psychology*, *76*, 587–589.

Ogden, J.A. (1985). Autotopagnosia: Occurrence in a patient with nominal aphasia and with an intact ability to point to parts of animals and objects. *Brain*, *108*, 1009–1022.

Pavlova, M., & Sokolov, A. (2000). Orientation specificity in biological motion perception. *Perception & Psychophysics*, *62*, 889–899.

Reed, C.L., & Farah, M.J. (1995). The psychological reality of the body schema: A test with normal participants. *Journal of Experimental Psychology: Human Perception and Performance*, *21*, 334–343.

Rhodes, G., Brake, S., & Atkinson, A. (1993). What’s lost in inverted faces? *Cognition*, *17*, 25–57.

Rhodes, G., Tan, S., Brake, S., & Taylor, K. (1989). Expertise and configural coding in face recognition. *British Journal of Psychology*, *80*, 313–331.

Scapinello, K.F., & Yarmey, A.D. (1970). The role of familiarity and orientation in immediate and delayed recognition of pictorial stimuli. *Psychonomic Science*, *21*, 329–331.

Shiffrar, M., & Freyd, J.J. (1993). Timing and apparent motion path choice with human body photographs. *Psychological Science*, *4*, 379–384.

Tanaka, J.W., & Farah, M.J. (1993). Parts and wholes in face recognition. *Quarterly Journal of Experimental Psychology*, *46A*, 225–245.

Tanaka, J.W., & Gauthier, I. (1997). Expertise in object and face recognition. In R.L. Goldstone, P.G. Schyns, & D.L. Medin (Eds.), *Psychology of learning and motivation: Vol. 36. Perceptual mechanisms of learning* (pp. 83–125). San Diego, CA: Academic Press.

Tanaka, J.W., & Sengco, J.A. (1997). Features and their configuration in face recognition. *Memory & Cognition*, *25*, 583–592.

Tanaka, J.W., & Taylor, M. (1991). Object categories and expertise: Is the basic level in the eye of the beholder? *Cognitive Psychology*, *23*, 457–482.

Wachsmuth, E., Oram, M.W., & Perrett, D.I. (1994). Recognition of objects and their component parts: Responses of single units in the temporal cortex of the superior temporal sulcus of the macaque. *Cerebral Cortex*, *4*, 509–522.

Yarmey, A.D. (1971). Recognition memory for familiar “public” faces: Effects of orientation and delay. *Psychonomic Science*, *24*, 286–288.

Yin, R.K. (1969). Looking at upside-down faces. *Journal of Experimental Psychology*, *81*, 141–145.

Young, A.W., Hellawell, D., & Hay, D.C. (1987). Configural information in face perception. *Perception*, *10*, 747–759.

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