Cross-Category Adaptation Reveals Tight Coupling of Face and Body Perception

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Faces and bodies are arguably the visual stimuli most relevant for human social interactions. Only recently, however, has research begun to reveal the interaction between face and body perception. Here we report on a recent study by Ghuman and colleagues and other behavioral and neuroimaging investigations that, taken together, provide compelling evidence for a tight coupling of face and body perception.

Imagine sitting in a café at a lively city square and observing the people around you. With a single glance you effortlessly determine whether you know the person you are looking at, whether it is a man or a woman, and what mood he or she is in. Most of that information is gathered from looking at the face. However, information we gain by observing other people’s bodies is also of great social interest. As for the face, the body provides hints about a person’s identity, gender, and emotion, although these cues can be more ambiguous than those for facial stimuli. Because accurate person recognition is of utmost importance in our social life, many researchers from cognitive science, psychology, and neuroscience have focused on studying how face recognition is accomplished. Surprisingly, research on body recognition has only recently attracted attention. Although both behavioral and neuroimaging evidences indicate that face and body perception rely on distinct mechanisms, research has now begun to address a fundamentally new question: how do face and body perception interact? Because faces and bodies are presented in isolation only in a laboratory setting and are rarely seen separately in real life, it is of great interest to study their interrelationship. In a series of behavioral experiments, Ghuman et al. (2010) did exactly this by exploring the impact of body perception on face perception.

Ghuman et al. (2010) first performed a body-to-face identity adaptation aftereffects (Leopold et al. 2001). For the identitiy-specific face adaptation effect, for example, adaptation to a face that is 100% Jack biases your percept of a face that is a composite of 50% Jack and 50% James toward “seeing” it as “more James-like” (Fig. 1A). Similarly, a prolonged exposure to a male face biases the following percept of a gender-neutral face—50% male and 50% female—toward the female face. This is called the gender-specific face adaptation effect (Fig. 1B; Webster et al. 2004). Ghuman et al. (2010), however, added a twist to the original face adaptation studies: instead of adapting subjects to a specific face, they adapted subjects to a body (without a face) and then assessed their perceptual biases on subsequently presented faces. Thus, they used cross-cate-
looked more like Jack or like James. Importantly, before subjects saw the morphed face, they were adapted to the body of either Jack or James. Ghuman and colleagues found that this prior exposure changed the likelihood according to which participants classified morphed faces as belonging to one of the individuals. When morphs were immediately preceded by 5 s by one of the bodies shown during the recognition task, participants were more likely to classify the face as depicting the respective other individual (Fig. 1C). This bias was attributed by the authors to a face aftereffect caused by adaptation to the body shape associated with the individual. Thus, according to this first experiment, it seems possible to induce an identity-specific face adaptation effect by presenting a body as the adapting stimulus.

In a series of control experiments Ghuman et al. (2010) corroborated this general finding and ruled out possible alternative explanations. First, they addressed the concern that imagery could have played a major role in producing these effects. Because the participants were quite familiar with both the respective faces and bodies, perceiving the body might have triggered the mental image of the associated face, which could then have biased the categorization of the morph. However, the authors were able to demonstrate a gender-specific body-to-face adaptation effect indicative of mechanisms other than mental imagery: gender-ambiguous morphs of faces were more likely to be categorized as female when preceded by a (headless) male body (Fig. 1D). Since the participants had never been exposed to a combination of these faces and bodies before, they could not recruit memory representations to conjure up a particular face associated with a particular body. Thus, an explanation of the body-induced bias in face processing along the lines of mental imagery seems much less likely. Furthermore, facial gender classification was similarly biased when participants were adapted to images showing bodies (with heads) from behind in which, again, no face information was present.

However, none of these experiments conclusively established the perceptual nature of the body-to-face-adaptation aftereffect. Rather, a bias could have been induced in later processing stages, for instance those related to decision making or semantic memory, rather than during earlier perceptual stages. To address this concern, Ghuman et al. (2010) argued that an effect of perceptual origin would be sensitive to the duration of the adapting (body) stimulus and that changing this duration should therefore change the shape of the psychometric function accordingly. A bias in a later processing phase related to decision or semantics, on the other hand, should be mostly unaffected by temporal manipulations. The results of an additional control experiment suggest that the effect is primarily perceptual in nature: the longer the duration of the (adapting) body stimulus, the stronger the effect on subsequent face processing. This finding is, again, consistent with similar results obtained in studies investigating pure face-related aftereffects.

One could also argue that if the body-to-face aftereffects were attributable to semantic factors, they might also occur if face morphs are preceded by images of gender-specific shoes or other “gendered” items such as purses. Another control experiment proved the opposite: although subjects explicitly declared that they were aware of the gender specificity of these objects, no corresponding aftereffects on the facial gender classification task were detected by Ghuman and colleagues, thereby further supporting the view of a perceptual origin of the effects.

Finally, returning to the concern about mental imagery, the authors asked whether their findings might have been induced by a putative tendency to additionally imagine a generic face, even if only a body is presented and has not been previously associated with a specific face. In the gender discrimination experiment, for example, participants could automatically imagine a generic female face when viewing a female body, thus biasing their judgment of a subsequent face toward males. To rule out this potential objection, Ghuman and colleagues devised an additional experiment in which subjects were engaged in a one-back working memory task on the body stimuli. According to self-report of the participants, performing this task successfully suppressed mental imagery. However, the subsequent facial gender classification task was again biased.

In conclusion, using a unique cross-category adaptation approach and thoroughly ruling out alternative explanations, Ghuman and colleagues were able to reveal an intricate interaction between body and face processing. It should be noted, however, that although the gender-specific body-to-face adaptation effect was very robust, the case is less clear for the identity-specific body-to-face adaptation effect. Face adaptation has been shown to facilitate face recognition (Rhodes et al. 2010); similarly, we might speculate that body-to-face adaptation aids in person recognition. Conclusively proving that this is the case, however, will necessitate further investigation of the identity-specific body-to-face adaptation effect.

Further behavioral evidence for a tight coupling between face processing and body processing comes from recent studies investigating the body inversion effect (BIE). The BIE is analogous to the face inversion effect (FIE), which refers to the fact that inverted faces are harder to memorize or discriminate than upright faces. The FIE is considered to be a marker of the “special” nature of face perception because inversion effects are much smaller for other object categories such as houses and cars. Although the first studies suggested that the BIE is of a magnitude similar to that of the FIE (Reed et al. 2003), recent studies have challenged this finding (Minnebusch et al. 2008; Yovel et al. 2010). Minnebusch and colleagues (2008) showed a BIE for bodies with heads (but with masked faces), but when they removed the head, the BIE was reversed: subjects performed better on inverted than on upright bodies. Yovel and colleagues performed a series of experiments to further investigate the role of the head in the BIE. They showed that omission of the head in a body stimulus markedly reduced the BIE (they did not find a reversed response pattern as Minnebusch et al. 2008 did). In contrast, the omission of other body parts such as one of the legs or the arms did not affect the BIE. Furthermore, Yovel et al. demonstrated that the BIE was also reduced for complete bodies that did not differ in head posture. However, this finding might be dependent on the task subjects had to perform; in the case of Yovel and colleagues they performed a same/different posture discrimination task, for which the head posture provides important cues. Whether retaining the same head posture in a same/different body-identity task (as used by Minnebusch et al. 2008) would lead to a similar reduction in the BIE is unclear. Minnebusch, Yovel, and colleagues provide evidence for the impact of the presence/absence of the head in body perception. Importantly, whereas Ghuman et al. (2010) demonstrate the influence of body perception on face perception, Minnebusch, Yovel, and colleagues demonstrate the opposite: the influence of head per-
ception on body perception. It is important to point out that these studies do not exactly address symmetric questions because head processing and face processing are clearly not the same thing and may influence body perception in different ways. To date, very few, if any, studies have directly investigated differences between face and head processing. Still, taken together these studies suggest an interaction between head/face and body processing.

Is the close relationship between face processing and body processing demonstrated by Ghuman et al. (2010) and the studies on the BIE reflected in how face and body stimuli are represented in the brain? In the ventral visual stream, the fusiform face area (FFA, one of the core regions of the face-processing network) and the fusiform body area (FBA, an important piece of the body-processing network) are closely adjacent to each other and are often found to overlap at typical imaging resolutions (Peelen and Downing 2005; Schwarzlose et al. 2005). Although these two regions can be separated at higher imaging resolutions (Schwarzlose et al. 2005), their close proximity suggests the potential for interaction. For example, it has been shown by Cox et al. (2004) that the fusiform face area is influenced by the presence of a body. A body with a correctly placed but degraded image of a face led to a high response in FFA whereas, e.g., a body and a face in incorrect spatial arrangement (face below body) elicited responses that were much weaker. Although we cannot definitely rule out that this finding is an artifact of the probable overlap of FFA and FBA at the imaging resolution used by Cox and colleagues, the fact that the arrangement did matter strongly suggests an interaction between FBA and FFA.

More lateral visual areas involved in the processing of faces (the occipital face area [OFA]) and bodies (the extrastriate body area [EBA]) are not nearly as proximal as FFA and FBA and do not directly border each other (Peelen and Downing 2005). They have also been shown to be functionally dissociable, in that transcranial magnetic stimulation (TMS) applied to the EBA affects body discrimination but not face discrimination, whereas TMS applied to the OFA affects face perception but not body perception (Pitcher et al. 2009); however, such a dissociation does not rule out the possibility that the two areas might influence each during the processing of whole bodies.

Some evidence of this type of influence is reported in a study that, in part, examined the influence of the presence of a face on “body processing regions” (Morris et al. 2006). These data showed that responses in these regions can be modulated by either the presence or the absence of a face, even when the body in the stimulus remains unchanged. Unfortunately, such a modulation of activity does not necessitate a real interaction; it might simply be the case that the presence of a face draws more attention to the stimulus, which in turn increases the signal in the respective region. Further, Chan and colleagues (2010) demonstrated that response patterns in the EBA more easily discriminated body parts that are closer to the face (such as shoulder or elbow) than body parts further away from the face. These results may suggest that responses in the body-selective region EBA are influenced by our overall viewing experience, which usually focuses our visual attention on nearby face and body parts. Such an explanation would further support a close interaction between face and body perception. The current data, however, cannot rule out the possibility that these results in the EBA could be driven more by the frequency with which upper body parts are seen to engage in complex, meaningful movements than their proximity to the face. Plainly, although neural evidence that body and face perceptions can influence each other is starting to emerge, the picture is still far from clear. In investigating face, body, and object perceptions, most imaging studies have pitted single stimulus classes against each other, although very few studies have yet looked at their potential influence on each other.

In conclusion, Ghuman et al. (2010) present compelling findings on the impact of body processing on face processing. In conjunction with other recent studies, this work suggests a tight interaction between face and body processing on a perceptual level that is worth pursuing further, both in psychophysics and neuroimaging. Such research may lead to a better understanding of our astonishing capabilities in recognizing other people from tip to toe.

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Disclosures

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