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Holistic Person Processing: Faces With Bodies Tell the Whole Story

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Faces and bodies are typically encountered simultaneously, yet little research has explored the visual processing of the full person. Specifically, it is unknown whether the face and body are perceived as distinct components or as an integrated, gestalt-like unit. To examine this question, we investigated whether emotional face–body composites are processed in a holistic-like manner by using a variant of the composite face task, a measure of holistic processing. Participants judged facial expressions combined with emotionally congruent or incongruent bodies that have been shown to influence the recognition of emotion from the face. Critically, the faces were either aligned with the body in a natural position or misaligned in a manner that breaks the ecological person form. Converging data from 3 experiments confirm that breaking the person form reduces the facilitating influence of congruent body context as well as the impeding influence of incongruent body context on the recognition of emotion from the face. These results show that faces and bodies are processed as a single unit and support the notion of a *composite person effect* analogous to the classic effect described for faces.

Keywords: emotion perception, context effects, facial and body expressions, holistic perception, composite effect

A glance is usually sufficient for extracting a great deal of social information from other people (Adolphs, 2002). Perceptual cues to characteristics such as gender, sexual orientation, emotional expression, attractiveness, and personality traits can be found in both the face and the body (e.g., face cues, Adolphs, 2003; Calder & Young, 2005; Ekman, 1993; Elfenbein & Ambady, 2002; Haxby, Hoffman, & Gobbini, 2000; Rule, Ambady, & Hallett, 2009; Thornhill & Gangestad, 1999; Todorov & Duchaine, 2008; Todorov, Pakrashi, & Oosterhof, 2009; Willis & Todorov, 2006; Zebrowitz, Hall, Murphy, & Rhodes, 2002; Zebrowitz & Montepare, 2008; body cues, de Gelder et al., 2006; Johnson, Gill, Reichman, & Tassinary, 2007; Peelen & Downing, 2005; Stevenage, Nixon, & Vince, 1999; Wallbott, 1998).

To date, most researchers have investigated the face and the body as discrete perceptual units, focusing on the processing of each source in isolation. Although this approach has proved extremely fruitful for characterizing the unique perceptual contributions of the face and body, surprisingly little is known about the processing of both sources combined. The aim of the current study was to shed light on the perceptual processing of the full person by examining whether the face and body in conjunction are processed as a holistic "person unit."

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On the basis of previous accounts, one may predict that faces and bodies are processed as two visual components of social information (Wallbott, 1998). These views argue that faces and bodies may differ in value, intensity, and clarity, and consequently the information from each must be weighted and combined by the cognitive system in order to reach a conclusion about the target (Ekman, Friesen, & Ellsworth, 1982; Ellison & Massaro, 1997; Trope, 1986; Wallbott, 1998). According to this approach, the face and body may influence each other. However, the influence is not synergistic, and the perception of the face and body is equal to the weighted sum of their parts (Wallbott, 1998).

By contrast, the hypothesis offered here is that the face and body are subcomponents of a larger perceptual person unit. From an ecological perspective this seems likely because under natural conditions, the visual system rarely encounters isolated faces and bodies (McArthur & Baron, 1983; Russell, 1997). According to this view, the face and body form a unitary percept that may encompass different properties than the two sources of information separately. In other words, the information readout from the full person may be more than the sum of the face and body alone.

Holistic Processing and the Composite Effect

Past research on social perception examining unitized gestalt processing has focused primarily on the face. Indeed, a hallmark of face perception is holistic processing by which individual facial components become integrated into a whole-face unit (Farah, Wilson, Drain, & Tanaka, 1995; Tanaka & Farah, 1993). Although isolated facial components do bear specific information (Smith, Cottrell, Gosselin, & Schyns, 2005; Whalen et al., 2004), their arrangement in the natural face configuration results in an integrated whole-face gestalt (Maurer, Le Grand, & Mondloch, 2002). One striking consequence of holistic processing is that the internal components are so strongly "glued" together that it becomes difficult to segment the face into its constituent elements (Tanaka & Farah, 1993; Todorov, Loehr, & Oosterhof, 2010).

The most widely used direct measure of holistic face processing is the composite face effect (Young, Hellawell, & Hay, 1987). In the composite face task, participants are presented with a face created from two discrepant face halves representing, for example, two identities (Young et al., 1987), emotional expressions (Calder, Young, Keane, & Dean, 2000), or social traits (Todorov et al., 2010) and are asked to make perceptual judgments concerning one half of the composite face while ignoring the other.

Characteristically, the irrelevant face half exerts strong interference because the two halves fuse to form a single holistic unit, leading to less efficient recognition of the relevant half (Hole, 1994; Le Grand, Mondloch, Maurer, & Brent, 2004; Michel, Rossion, Han, Chung, & Caldara, 2006; Young et al., 1987; Zhu et al., 2010). This effect does not merely rise from simple response competition interference between the two face halves (Richler, Cheung, & Gauthier, 2011), but rather because the two sources of information are perceived as one (Richler, Cheung, Wong, & Gauthier, 2009). Thus, in the composite effect the influence of the irrelevant half is obligatory, based on innate predisposition (Turati, Di Giorgio, Bardi, & Simion, 2010) followed by years of experience in processing upright whole faces (Richler, Mack, Gauthier, & Palmeri, 2009).

Composite face processing can be disrupted, however, by laterally misaligning the two face halves (Young et al., 1987). Although the perceptual information remains identical within the face halves, the misalignment fractures the composite gestalt of the face. The composite effect (i.e., the difference between performances with aligned and misaligned faces) serves as a central index of holistic face processing (Maurer et al., 2002).

To date, the vast majority of researchers have constrained their exploration of holistic processing to the isolated face. Although faces per se are certainly important social signals, this approach may not be telling the whole story, as faces are rarely encountered in isolation. There are several reasons to consider the possibility of holistic face–body processing. As noted, faces appear in conjunction with bodies positioned in situations, which may convey highly relevant contextual information (Aviezer, Hassin, Bentin, & Trope, 2008; Aviezer, Hassin, Ryan, et al., 2008; Barrett & Kensinger, 2010; Barrett, Lindquist, & Gendron, 2007; de Gelder, et al., 2006). Furthermore, recent research has demonstrated that the perception of faceless human bodies also invokes specialized holistic processing mechanisms (de Gelder, 2006; Minnebusch & Daum, 2009; Reed, Stone, Bozova, & Tanaka, 2003; Yovel, Pelc, & Lubetzky, 2010). For example, similar to that of faces, discrimination of inverted bodies is worse than the discrimination of upright bodies (Reed et al., 2003).

Finally, neuroscientific evidence lends support to the notion of tightly linked face and body processing. For example, neuroimaging investigations have indicated that regions selective for the processing of faces and bodies are located in close proximity (Peelen & Downing, 2005, 2007). Specifically, the two areas associated most strongly with body perception, the extrastriate body area and the fusiform body area, are located in very close proximity to regions strongly associated with face perception, the occipital face area and the fusiform face area, respectively (Peelen & Downing, 2007). Interestingly, a recent study directly contrasting emotional faces with emotional bodies has indicated that the fusiform region is activated by both faces and bodies (van de Riet, Grèzes, & de Gelder, 2009). Hence, the plausibility of holistic processing of faces and bodies is also evident from the proximity and potential connectivity of the neural structures underlying each source in isolation.

In summary, given the importance of both body and face perception, and given their shared processing properties, we suggest that holistic processing may not be confined to the isolated face or isolated body but may rather extend to a full person unit.

Exploring Holistic Effects With Emotional Face–Body Integration

In the classic holistic face effect (Young et al., 1987), the identity judgment of one face half is influenced by the incongruent identity of the other face half. However, a direct translation of that task to the face–body realm may not be ideal for testing holistic effects. Specifically, identity is usually inferred from the face, especially when still images are involved (O'Toole et al., 2011). One useful alternative to identity is emotional expression, in which the face and body convey different emotions (Aviezer, Hassin, Ryan, et al., 2008; Meeren, van Heijnsbergen, & de Gelder, 2005). Human emotions are strongly expressed and recognized from both the face and the body. Hence, an emotional face–body composite can be analogous to the classic face composite stimuli. Furthermore, as next reviewed, the recognition of emotion from the face may be highly influenced by the emotion expressed by the body.

The vast majority of research on facial expressions perception has focused on the characteristics of viewing isolated faces (Adolphs, 2002, 2003; Darwin, 1872; Ekman, 1992; Hassin & Trope, 2000; Öhman, 2000; Peleg et al., 2006; Russell, 1997; Tracy & Robins, 2008; Waller, Cray, & Burrows, 2008). When viewed in isolation, specific muscular configurations in the face act as signals that accurately and rapidly convey discrete and basic categories of emotion (Ekman, 1993; Ekman & O'Sullivan, 1988; Smith et al., 2005; Tracy & Robins, 2008; Young et al., 1997). Notwithstanding the importance of the aforementioned studies, they may have been limited by constraining their investigations to the recognition of isolated faces. Real-life facial expressions, however, are typically embedded in a rich and informative context. Specifically, the expressive body appearing in affective situational scenes is a prime candidate for such contextual influence on the face.

The fact that previous research on facial expressions perception has relied mostly on isolated faces, while minimizing the role of the body (or other sources of context), is understandable. This methodological choice may have been guided by the notion that basic facial expressions are viewed as universal (Ekman, 1993) and categorically discrete signals of emotion (Etcoff & Magee, 1992; Young et al., 1997) assumed to be directly mapped to specific emotional categories (Buck, 1994; Ekman, 1992). In its extreme formulation, it has been posited that the recognition of basic prototypical facial expressions is relatively immune to context influence (Buck, 1994; Ekman & O'Sullivan, 1988; Nakamura, Buck, & Kenny, 1990), and that when a face and body (or other context) are of equal clarity, the recognition of the former will dominate the latter (Ekman et al., 1982).

Recent investigations, however, have shown that facial expressions are influenced by body context more than had been assumed (Aviezer, Hassin, Bentin, & Trope, 2008; Aviezer, Hassin, Ryan, et al., 2008; de Gelder et al., 2006; Meeren et al., 2005; Van den Stock, Righart, & de Gelder, 2007). In fact, under certain conditions, incongruent body context can dramatically shift the emotional category recognized in basic facial expressions (Aviezer, Hassin, Ryan, et al., 2008). Indeed, participants cannot disregard the body even if they have no reason to process it or if they are explicitly instructed and motivated (via a monetary reward) to ignore it (Aviezer, Bentin, Dudarev, & Hassin, 2011).

To demonstrate the impact of bodies on faces, Aviezer, Hassin, Ryan, et al. (2008) "planted" prototypical pictures of disgust faces on bodies of models conveying different emotions (such as anger and sadness). Their results showed that placing a face in body context may induce striking changes in the recognition of emotional categories from the facial expressions. Importantly, that study revealed that a given facial expression is not uniformly influenced by all emotional contexts, despite the contexts being equally recognizable. Rather, the magnitude of contextual influence is strongly correlated with the degree of confusability between the expression of the target face (i.e., the face being presented) and the facial expression that is typically associated with the emotional context: The more confusable these two faces are, the stronger the influence. One source for this confusability may be the shared perceptual information across facial expressions. For example, disgust faces are perceptually similar to anger faces, and less so to sadness faces (Susskind, Littlewort, Bartlett, Movellan, & Anderson, 2007). And indeed, an anger context results in striking contextual influence on disgust faces, whereas an equally powerful and recognizable sadness context induces much weaker effects on the same disgust faces (Aviezer, Hassin, Ryan, et al., 2008). Of course, mixed emotional messages in real-life settings are probably far more complex and subtle (Matsumoto & Hwang, 2010). Nevertheless, the emotional face–body paradigm is an extremely useful tool for exploring the perceptual process of face–body integration.

In the current investigation, we exploited this characteristic body–face influence as a tool for exploring holistic person processing. If the whole person is processed as a holistic unit, then the ecological positioning of the face relative to the body would be crucial for the perceptual gestalt to form (see Figures 1A and 1B). Misaligning the face and body should weaken the perceptual unit and lessen the influence of the body on the face compared with when the two expressive sources are aligned (Figures 1C and 1D). Misalignment should improve face accuracy when the context is incongruent, and it should reduce accuracy when the body context is congruent with the face. Furthermore, such misalignment effects should be most apparent when the body induces a strong (facilitation or impeding) influence on the face relative to its baseline recognition in isolation. This should be the case because only in these cases are the face and body strongly integrated. By contrast, when the body only weakly influences face recognition relative to baseline, the face and body are not truly integrated, and hence there is no strong unit to fracture by misalignment (Aviezer, Hassin, Ryan, et al., 2008).

In a recent study, Mondloch (2012, Experiment 1) investigated the influence of congruent and incongruent body context (sad and fear faces crossed with sad and fear bodies) on facial expression perception in children versus adults. The results demonstrated that

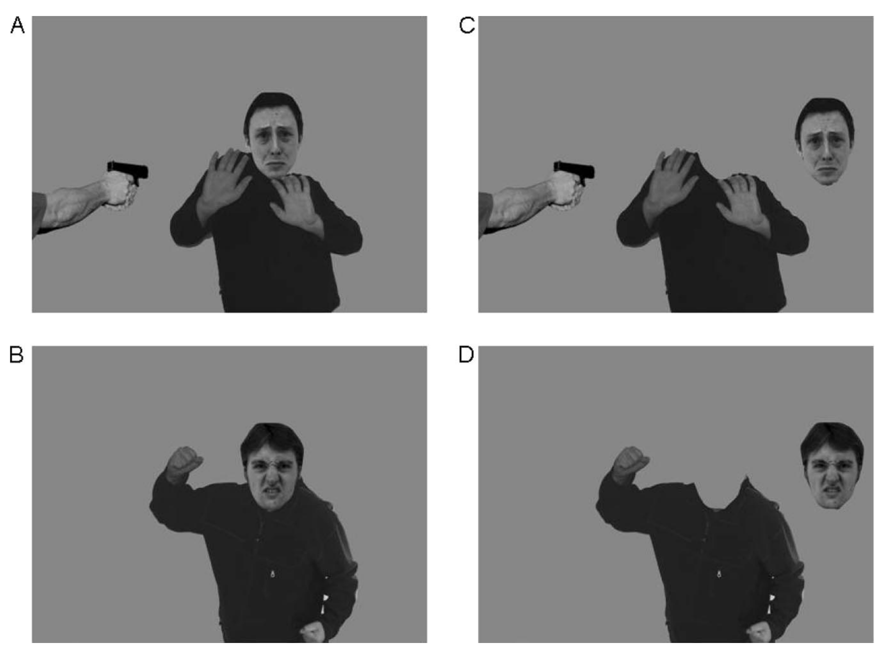

Figure 1. Examples of aligned and misaligned face–body combinations used in Experiment 1. Aligned incongruent stimuli include sad face on fearful body (A) and disgust face on anger body (B). Spatially misaligning the face from the body, as seen in Figures 1C and 1D, results in misaligned incongruent stimuli. Adapted with permission from *Moving Faces, Looking Places: The Amsterdam Dynamic Facial Expressions Set (ADFES)*, by S. T. Hawk, J. van der Schalk, & A. H. Fischer, 2008.

8-year-olds, much like adults, show reduced performance with incongruent body context. Relevant for the current study, Mondloch also presented faces and bodies in a misaligned manner and found that misalignment reduced the influence of incongruent bodies but had no impact on the influence of congruent bodies. Although the main finding of that study (i.e., incongruent bodies influence face perception) provides insight into body–face influence in children, the misalignment data cannot be interpreted as evidence for face–body holistic processing, for several critical limitations. First, Mondloch used a forced-choice categorization task with two emotions (appropriate for 8-year-olds); however, that paradigm cannot distinguish between a true holistic perceptual effect and a response interference Stroop-like effect (Richler, Gauthier, Wenger, & Palmeri, 2008; Richler et al., 2009). Indeed, the classic composite design (Young et al., 1987) has recently been criticized severely for failing to differentiate perceptual from decisional as well as response interference factors, and more powerful, fully balanced designs have been devised to address this matter (Richler et al., 2011).

Second, as noted by Mondloch (2012), the effects of misalignment reported in her study may simply reflect the ability of participants to efficiently ignore the peripheral body while focusing on a distant dislocated head; hence, the data cannot speak for a perceptual holistic effect. Third, because baseline recognition of the facial expressions was not obtained in that study, it was impossible to determine whether misalignment facilitated recognition or whether alignment reduced recognition. Indeed, the results in that study failed to demonstrate an effect of alignment with congruent stimuli. Finally, a fourth limitation in that study was the exclusive use of an emotion categorization task that increases susceptibility to decisional over perceptual factors (as opposed to a simultaneous matching task that highlights perceptual processing).

Thus, although the data in Mondloch's (2012) study nicely demonstrate that children's face perception is influenced by body context (which was indeed the main aim of that study), the misalignment data are unfortunately insufficient for determining whether the face and body are processed holistically. In the current study, we provide a comprehensive examination of holistic face–body processing. In three experiments, we tested for strong evidence of holistic face–body processing while ruling out alternative explanations for misalignment effects (Richler et al., 2011).

Outline of the Current Research

The current research consisted of three experiments in which we used an analogous task to the composite face task (Young et al., 1987) by spatially misaligning the face from the body. In Experiment 1, we simulated the classic composite face task by manipulating the alignment of the faces and bodies and examining the effect of alignment on the recognition of facial expressions combined with congruent and incongruent bodies. Importantly, we used a wide range of face–body stimuli, allowing a rigorous comparison of body combinations that induce strong versus weak contextual influence on the faces. In Experiment 2, we manipulated the spatial relation between the face and the body and examined its impact on the composite effect. In addition, we examined the effect of nonecological composites in which the face is physically connected to the body albeit in an unnatural position. Finally, in Experiment 3, we used an emotion matching paradigm and a recently introduced, fully balanced design, the "complete design" (Richler et al., 2008), which controls for response competition biases when testing for holistic perceptual changes.

Experiment 1

In Experiment 1, we tested for holistic processing by using facial expressions seamlessly paired or spatially misaligned with emotional body context. As noted, the influence of incongruent body context on facial expression recognition is not merely a function of the response conflict between the two sources per se. Rather, the response is determined by the specific confusability arising between the target facial expression (i.e., the face being presented) and the facial expression that is prototypically associated with the emotional body (Aviezer, Hassin, Ryan, et al., 2008). Confusability can arise from a variety of reasons, such as shared perceptual similarity (Susskind et al., 2007) or shared dimensions of valance and arousal (Carroll & Russell, 1996) between the presented face and body-expected face. Furthermore, confusability may be asymmetrical: Category A may be more confusable with Category B, than vice versa (Nosofsky, 1991; Tversky & Gati, 1978).

The fact that specific incongruent face–body combinations induce a compelling confusability, whereas others do not, is useful when studying holistic integration. Face–body misalignment should be most consequential in the cases that the body exerts a strong influence on the face, but less so when the influence is weak. In our stimuli we used a crossed design with four emotional bodies by four emotional faces, resulting in 16 face–body combinations. However, on the basis of previous studies (Aviezer, Hassin, Ryan, et al., 2008), we did not expect all face–body combinations to induce strong contextual influence on the faces. For example, previous work testing a small subset of combinations has documented strong body effects on face recognition for disgust faces on anger bodies, anger faces on disgust bodies, and sad faces on fearful bodies. By contrast, weak contextual effects were found for disgust faces on fearful bodies and sad faces on anger bodies (Aviezer, Hassin, Bentin, & Trope, 2008; Aviezer, Hassin, Ryan, et al., 2008).

To empirically establish strong influence and weak influence face–body combinations in our 16 face–body combinations, we ran an independent group of participants who categorized all the aligned face–body composites that were then used (in both aligned and misaligned form) in the main experiment. By comparing the recognition of each facial expression in isolation to its recognition when embedded in context, we differentiated face–body combinations in which the face recognition was significantly facilitated or diminished by the context (i.e., strong influence) from face–body combinations in which the body did not exert significant influence on the face (i.e., weak influence). On the basis of these independent results, we established face–body combinations (for both Experiments 1 and 2) in which the face was expected to be strongly or weakly influenced by the context.

Our central predictions in the main experiment focused on the strong influence contextual pairs. For these strong influence face–body combinations, we predicted that (a) accuracy would be higher for faces with congruent bodies compared with baseline, (b) accuracy would be lower for faces with incongruent bodies compared with baseline, and (c) these differences would be stronger for aligned compared with misaligned face–body combinations. We expected the impact of face–body misalignment to be most consequential in the cases where the body exerted a strong contextual influence on the face. By contrast, when the body exerted a weak influence, the effect of misalignment was expected to be less consequential.

Method

Participants. Forty-one participants from the Princeton University community (28 female, 13 male), mean age 22.3 years (range: 18–46), took part in the study. Twenty participants were assigned to independently determine the contextual strength of face–body pairs, and a separate group of 21 participants took part in the main experiment that tested holistic perception using misalignment.

Stimuli. Images of 10 individuals each posing prototypical facial expressions of disgust, sadness, anger, and fear were obtained from three standardized sets of prototypical facial expressions (Ekman & Friesen, 1976; Hawk, van der Schalk, & Fischer, 2008; Langner et al., 2010). We purposefully used a wide range of basic emotion face sets to include more current-looking models than those portrayed in the classic and widely used Ekman and Friesen (1976) set. Although we used a wide range of expressions, they were all of negative valance. This choice was made because standard sets of basic expressions typically include only happiness as a positive facial expression. Consequently, the occurrence of confusability patterns between facial expressions, crucial for body–face influence, cannot be properly tested when using happy faces with no other positive faces.

Each of the 40 faces was combined with four prototypical pictures of emotional bodies conveying anger, disgust, sadness, and fear. The body expressions have been validated in multiple studies, and past work has shown them to be highly recognizable exemplars of their respective emotions (Aviezer, Hassin, Ryan, et al., 2008). The usage of a minimal number of highly prototypical bodies served to minimize confusability within the bodies and to lessen the need to devote attention to the analysis of the bodies. Hence, if anything, participants should have found it easier to disregard the repetitive bodies and simply focus on the face.

As can be seen in the examples in Figure 1, the body expressions included a wide range of affective information including emotional body language, posture, gestures, and emotional paraphernalia, all contributing to a reliable scene in which the body of the person was convincingly expressing an emotion. The anger image portrayed an individual leaning forward and waving a threatening fist. The disgust image portrayed an individual handling a dirty pair of underwear, holding the item between his thumb and index finger distanced from his body. The sad image portrayed an individual standing in a cemetery beside a tombstone in a heartbroken pose. The fearful image portrayed an individual slightly crouching with both hands extended in a defensive manner while being threatened by a gun. The emotional bodies and faces were converted to gray scale and appeared on a light gray background. For the control stimuli, the faces appeared in isolation, with bodies cropped out, or the bodies appeared with the faces cropped out. The size of the face–body combinations subtended an overall visual angle of $\sim 13° \times 6°$ when viewed from 60 cm.

We used a fully crossed design so that each of the four facial expression categories was paired with each of the four body expression categories, reducing any response biases to specific categories. Furthermore, using a wide range of crossed face–body expressions requires more subtle and in-depth analysis of the emotions, as opposed to more simple, two-choice emotion tasks (de Gelder et al., 2006; Mondloch, 2012). In the independent determination of contextual strength, participants only viewed aligned face–body stimuli. In the main task, all face–body combinations appeared in both aligned and misaligned form. Aligned face–body combinations were created by seamlessly aligning the head with the body in a proportional, realistic-looking manner (e.g., Figures 1A and 1B). Misaligned combinations were created by cropping the head and displacing it horizontally beside the shoulder (e.g., Figures 1C and 1D).

In addition to the combined faces and bodies, the independent determination of contextual strength and the main experiment included faces with no bodies serving as baseline control as well as bodiless faces that served to confirm that the bodies were well recognized. The presentation of isolated stimuli in a separate block allowed us to readily compare the overall clarity of faces with bodies and to examine whether certain categories of emotion are better recognized from faces versus bodies. Note that our main question at hand was a comparison of aligned versus misaligned faces. Therefore, the presentation of baseline faces in a separate block is nonconsequential for the critical comparison that involved the impact of a separate manipulation (i.e., face and body connected or separated).

Design. In the determination of contextual strength task, a 4 (face: anger, disgust, fear, sadness) $\times$ 5 (body context: anger, disgust, fear, sadness, none) repeated design was used. This was followed by specific analyses within each face category comparing recognition of isolated and contextualized faces in order to establish strong versus weak face–body combinations. Subsequently, in the main analysis we tested for holistic perception with a 2 (body congruency: congruent, incongruent) $\times$ 2 (alignment: aligned, misaligned) $\times$ 2 (body influence: strong, weak) repeated design.

Procedure. In both the determination of contextual strength task and the main experiment, participants were instructed to categorize the emotion of the facial expressions portrayed in the face–body combinations. In the control block, participants were instructed to categorize the emotion of the expressions (faces or bodies). Each trial began with a 500-ms fixation followed by an expressive image that appeared on-screen for 1,000 ms. A forced-choice response format was used with the options of anger, sadness, disgust, and fear, which appeared on-screen below the image and remained visible until a response was made. Aligned and misaligned stimuli were presented in one block. Stimuli were randomly presented within blocks, and blocks were randomly ordered between participants.

Dependent measures. Our primary interest in the main experimental task was whether misalignment would reduce the influence of body context on face recognition. To test this, we used difference scores that were obtained by subtracting, for each face category, the baseline average recognition of the faces in isolation (i.e., with no bodies) from the average recognition of the faces when presented with body context. With this measure, positive scores reflect a contextually induced recognition enhancement, and negative scores reflect a contextually induced recognition decline, compared with the isolated face recognition.

Unlike the classic composite face paradigm, in which the interference of the incongruent face half is mostly expressed in reduced response times (RTs), while categorization is fairly accurate (Calder et al., 2000; Young et al., 1987), the most striking effect of incongruent body context on face recognition is an actual change in the emotion category recognized from the face (Aviezer, Hassin, Ryan, et al., 2008). Furthermore, our design—in which stimuli were presented for a relatively extended duration and responses were not limited to a duration window—was optimized to detect changes in accuracy rather than speeded RT. Furthermore, past work has shown that strong influence incongruent combinations greatly reduce the number of correct responses, resulting in a small number of correct RT data points. Because of these considerations, RT analyses would be hard to interpret and add little information to the recognition scores. Hence, as in other social judgment, holistic face paradigms (Abbas & Duchaine, 2008; Todorov et al., 2010), in the current and following experiments we report the actual accuracy of judgments rather than RTs.

Results

Determining contextual strength: Strong and weak face–body combinations. One participant was removed from the analysis because of a misunderstanding of task instruction. To assess the influence of the body context on the faces, we first ran a 4 (face: anger, disgust, fear, sad) × 5 (body context: anger, disgust, fear, sad, none) repeated analysis of variance (ANOVA). The analysis revealed a significant effect of the face, $F(3, 54) = 9.6$, $p < .001$, $\eta_p^2 = .38$, and a significant effect of the body context, $F(4, 72) = 7.76$, $p < .001$, $\eta_p^2 = .30$. As expected, a significant Face × Body Context interaction emerged indicating that faces were more influenced by some body contexts than by others, $F(12, 216) = 24.8$, $p < .001$, $\eta_p^2 = .58$. Our main objective in this manipulation check was to establish face–body pairs in which the body exerted a significant contextual influence on the face. To this end, we ran separate ANOVAs for each of the four facial expressions, followed with paired tests comparing the recognition of each of the four contextualized faces to the same face with no context. Note that in this approach, the line between strong and weak effects is arbitrary, based on the statistical power of our pilot study (which was comparable to the power of the main misalignment experiment).

The mean recognition of the four facial expressions in each of the body contexts, as well as the baseline face recognition (with no body context), is plotted in Figure 2. The separate ANOVAs revealed significant contextual effects for all facial expression categories: anger, $F(4, 72) = 21.8$, $p < .001$, $\eta_p^2 = .62$; disgust, $F(4, 72) = 25.2$, $p < .001$, $\eta_p^2 = .58$; fear, $F(4, 72) = 11.3$, $p < .001$, $\eta_p^2 = .38$; and sadness, $F(4, 72) = 19.5$, $p < .001$, $\eta_p^2 = .52$. Paired t tests were next run within each facial expression comparing contextualized and baseline recognition of the faces to reveal the combinations in which the bodies significantly influenced face recognition (i.e., strong influence) as well as the combinations in which

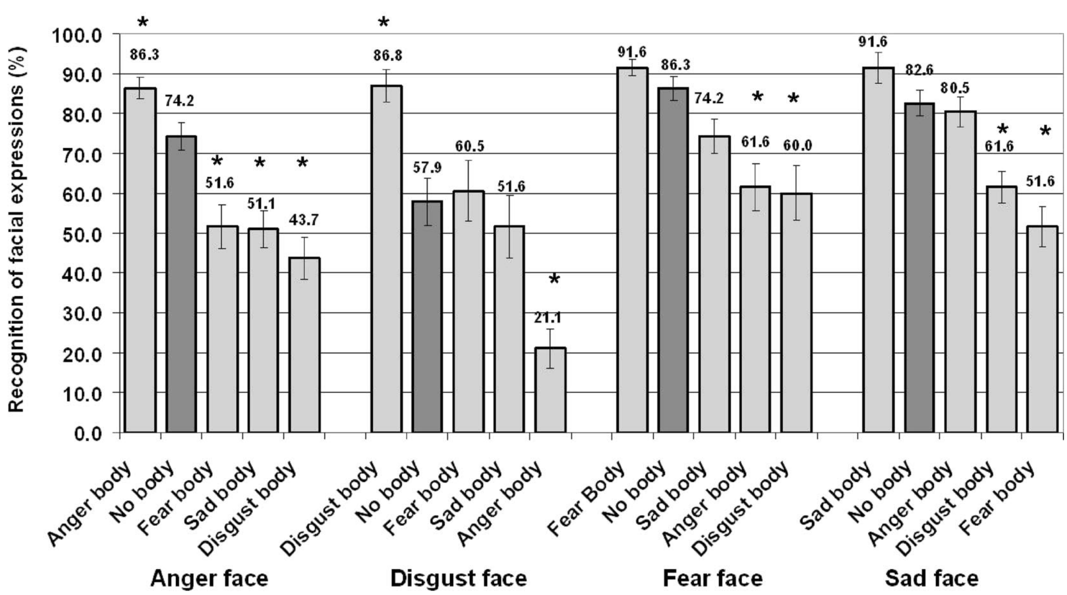

Figure 2. Determining the strength of face–body combinations in Experiment 1. Mean recognition (and standard error) is for the categorization of facial expressions aligned with emotional bodies. Facial expressions and body expressions posing anger, disgust, fear, and sadness were fully crossed. The "no body" dark bar refers to the baseline face recognition with no body. An asterisk above a combination indicates a strong influence face–body pair in which the body significantly influenced the recognition of the face (improving recognition in case of a congruent body or decreasing recognition in case of an incongruent body), compared with the baseline face recognition with no body. No asterisk indicates a weak influence face–body pair in which the body exerted relatively weak influence on the recognition of the face, compared with baseline face recognition.

they did not (i.e., weak influence). A Bonferroni-adjusted alpha level of $p < .003$ (.05/16) was used to correct for multiple comparisons.

Within anger faces, congruent anger bodies increased recognition compared with baseline ($p < .001$), whereas disgust, fear, and sad bodies significantly reduced recognition compared with baseline (all ps $< .001$). Within disgust faces, congruent disgust bodies increased recognition, and incongruent anger bodies decreased recognition (all ps $< .001$); however, incongruent sad and fearful bodies did not significantly influence recognition ($p > .29$ and $p > .68$, respectively). Within fear faces, incongruent anger and disgust bodies significantly reduced recognition (all ps $< .001$); however, congruent fear bodies and incongruent sad bodies did not significantly influence recognition ($p > .14$ and $p > .008$). Finally, within the sad faces, incongruent disgust and fear bodies significantly reduced recognition (all ps $< .001$); however, congruent sad bodies and incongruent anger bodies did not influence recognition ($p > .09$ and $p > .60$, respectively).

In summary, the results of the contextual strength task confirm previous findings indicating that the same faces may be strongly influenced by some contextual bodies yet weakly influenced by others (Aviezer, Hassin, Ryan, et al., 2008) and, conversely, that the same body may strongly influence some faces but not others (Aviezer et al., 2009). On the basis of the analysis, we predicted that face–body misalignment would most notably reduce the beneficial contextual influence for strong influence congruent combinations (i.e., disgust faces on disgust, anger faces on anger) and less so for weak influence congruent combinations (i.e., fear faces on fear, sad faces on sad). Conversely, we predicted that misalignment would most notably reduce the detrimental influence of strong influence incongruent combinations (i.e., anger faces on sad, fear, and disgust; disgust faces on anger; fear faces on anger and disgust; and sad faces on disgust and fear) and less so for weak influence incongruent combinations (i.e., disgust faces on fear and sad, fear faces on sad, and sad faces on anger). Note that although different exemplars appeared in each condition, our main interest was comparing, within each condition, the difference between aligned and misaligned stimuli.

Main experiment: Baseline recognition of isolated faces and bodies. The mean recognition of faceless emotional bodies was 94.6 ($SD = 17.38$). All bodies were highly recognizable—anger, $M = 98.8$, $SD = 5.4$; disgust, $M = 96.4$, $SD = 16.3$; fear, $M = 94.05$, $SD = 13.4$; and sadness, $M = 89.2$, $SD = 26.8$—with no significant differences between emotions, $F(3, 60) = 1.1$, $p > .30$.

The mean recognition of facial expressions without bodies was 73.3 ($SD = 20.8$). Facial expressions were recognized well above chance (chance level = 25%)—anger, $M = 73.8$, $SD = 15.6$; disgust, $M = 54.7$, $SD = 25.4$; fear, $M = 80.9$, $SD = 12.0$; and sadness, $M = 75.2$, $SD = 14.5$—although some categories were better recognized than others, $F(3, 60) = 15.6$, $p < .001$, $\eta_p^2 = .43$. Paired comparisons indicated that fear faces were better recognized than all other expressions ($p < .01$) and that disgust faces were more poorly recognized than all other expressions ($p < .01$). No other differences were significant (all ps $> .2$).

Main experiment: Assessing the impact of face–body misalignment. Having previously established the face–body pairs in which the body strongly influenced face recognition, we proceeded in the main experiment to examine the effect of alignment on congruency as a function of the strength of the body context. Difference scores were obtained by subtracting, for each face category, the baseline average recognition of the faces in isolation from the average recognition of the body-contextualized faces. The mean recognition difference scores were analyzed with a 2 (body congruency: congruent, incongruent) × 2 (alignment: aligned, misaligned) × 2 (body influence: strong, weak) repeated ANOVA.

The results showed a main effect of body congruency, $F(1, 20) = 25.1$, $p < .001$, $\eta_p^2 = .55$; no effect of alignment, $F(1, 20) = 2.8$, $p > .10$, $\eta_p^2 = .12$; and no effect of body influence, $F(1, 20) = 2.7$, $p > .10$, $\eta_p^2 = .12$. All two-way interactions were significant: Body Influence × Body Congruency, $F(1, 20) = 9.5$, $p < .006$, $\eta_p^2 = .32$; Body Influence × Alignment, $F(1, 20) = 0.54$, $p < .03$, $\eta_p^2 = .21$; and Alignment × Body Congruency, $F(1, 20) = 6.8$, $p < .02$, $\eta_p^2 = .25$. Critically, a significant three-way interaction was found indicating that the influence of body congruency on the recognition differed as a function of the alignment, and that this pattern differed depending on the strength of the body influence, $F(1, 20) = 27.04$, $p < .001$, $\eta_p^2 = .57$ (see Figure 3).

To further explore the three-way interaction, we ran separate Alignment × Body Congruency ANOVAs for the strong and weak body influence combinations. For the strong body influence combinations, a significant effect of body congruency was found indicating that congruent stimuli were better recognized than incongruent ones, $F(1, 20) = 29.1$, $p < .001$, $\eta_p^2 = .59$, but the effect of alignment was not significant, $F(1, 20) = 0.05$, $p = .80$, $\eta_p^2 = .002$. Importantly, a significant Alignment × Body Congruency interaction was found, $F(1, 20) = 23.6$, $p < .001$, $\eta_p^2 = .54$. Planned comparisons showed that when the influence of the body was strong, facial recognition with congruent bodies was higher with aligned than with misaligned stimuli, $t(20) = 3.2$, $p < .004$. Conversely, facial expression recognition with incongruent bodies was lower with aligned than with misaligned stimuli, $t(20) = 5.1$, $p < .001$.

We next examined the weak influence combinations with a similar Alignment × Body Congruency ANOVA. The effect of body congruency was not significant, $F(1, 20) = 2.9$, $p > .10$, $\eta_p^2 = .127$, but an effect of alignment was found indicating that recognition was better with aligned than with misaligned combinations, $F(1, 20) = 7.1$, $p < .02$, $\eta_p^2 = .26$. However, the Alignment × Body Congruency interaction was not significant, $F(1, 20) = 1.6$, $p = .21$, $\eta_p^2 = .07$.

Discussion

In Experiment 1, we presented emotional faces and bodies in aligned or misaligned form to examine whether they are processed holistically. We found evidence for a *composite person effect*, apparent by the fact that a small misalignment of the head from the body disrupts the holistic person gestalt and reduces the influence of the body on the face. This in turn can hinder or improve face accuracy, depending on the congruency between the face and the body, and depending on the strength of the influence from the body to the face. When the face emotion is strongly and convincingly influenced by the body emotion, holistic perception may enhance recognition as a function of congruency. By contrast, when the face emotion is clearly discordant with the body emotion, the face is only weakly influenced by the body, and misalignment is less consequential.

These findings indicate that task-irrelevant bodies exert influence on face categorizations but that this influence is maximal only

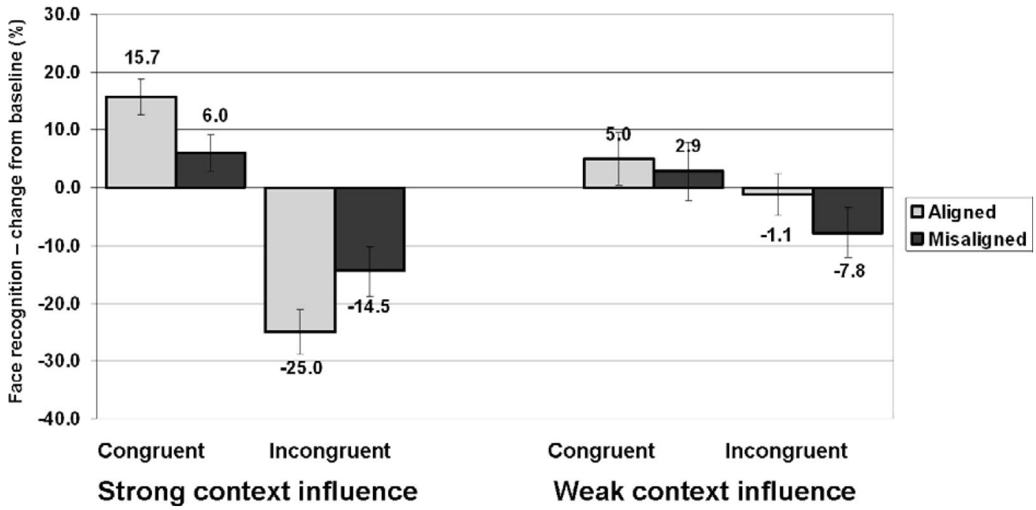

Figure 3. The influence of alignment on mean facial expression recognition as a function of the face–body congruency and strength of influence in Experiment 1. Mean recognition scores (and standard error) are expressed as difference scores compared with the baseline recognition of the face with no body. Misalignment reduced the impact of the body on the face in the strong influence face–body combinations: Recognition improved in case of incongruent context and was reduced in case of congruent context. The weak influence face–body combinations show little impact of misalignment, as they, by definition, are only weakly influenced by the body.

when the faces and bodies are aligned. Note that although the misalignment results demonstrate holistic effects, the body may also influence the face by merely serving as context, much like a short vignette (Carroll & Russell, 1996). However, the body context was identical in the aligned and misaligned groups. Therefore, the misalignment effects occur above and beyond any general context effect, and they demonstrate a unique contribution of the person gestalt to the perception of facial expressions.

Although these findings show that misalignment of the face and body creates a clear composite effect, one may argue that its source is not necessarily a disruption of holistic-like processing. One potential concern, shared with many of the classic demonstrations of holistic processing in faces, is that shifting the head from the body not only decouples the face from the body but also distances the two parts from each other. As a result, it is not clear whether the effect stems from the spatial distancing of the bodies or rather from a disruption of holistic processing.

An additional, more complex concern is that the mere physical separation (rather than distancing) of the face from the body may underlie the effect, as oppose to a perceptual breakdown in holistic processing. This may be the case because whole objects, regardless of their nature, are often the unit of attentional selection, and it is difficult to avoid processing irrelevant features of a selected object (Richard, Lee, & Vecera, 2008). Similarly, two features of the same object are processed more efficiently than two features across different objects (Duncan, 1993). These concerns were both addressed in Experiment 2.

Experiment 2

The aim of Experiment 2 was to examine the relation between emotional face recognition and the degree and nature of spatial misalignment between the face and the body. To this end, we introduced varying levels of misalignment between the face and the body. In the aligned condition, the faces and bodies were aligned in a natural position, as they were in the equivalent aligned condition in Experiment 1. In two of the misaligned conditions, the faces were physically disconnected from the body, but in one of these conditions the face–body gap was larger than the other. If our misalignment effects resulted from the mere distance between the face and the body, presumably allowing participants to process the face with minimal attention to the body, then greater misalignment effects should occur when the face and body are more distant. Conversely, if the misalignment effect reflects a perceptual breakdown, the distance per se should not create a reliable increase.

Importantly, we also included a misaligned connected condition in which the faces and bodies were misaligned but physically connected, albeit in an unnatural position. If the findings in Experiment 1 resulted from the mere face–body separation and creation of two objects, then the misalignment effect should be eliminated by such a manipulation. Although we expected some effect of the mere connection of the face and body to a single object (Duncan, 1993), we predicted that the misalignment effect would still hold. Hence, an ecologically awkward and misconnected (but not disconnected) face was expected to reduce holistic processing compared with the same face naturally aligned with the body.

Method

Participants. Twenty-seven Princeton University students (19 female, eight male), mean age 19.2 years (range: 18–21), participated in the study for course credit or payment.

Stimuli. Images of 10 individuals each posing prototypical facial expressions of disgust and sadness were selected from the same sets as in Experiment 1. These 20 faces were combined with pictures of emotional bodies conveying anger, disgust, sadness, and fear, similar to those used in Experiment 1. To reduce the number of combinations and shorten testing duration, we did not cross all faces with all bodies. However, the selected face–body combinations were similar to those shown in Experiment 1 to create congruent and incongruent face–body combinations of strong and weak influence. Face–body combinations included (a) disgust faces on disgust bodies (congruent–strong influence); (b) sad on sad (congruent–weak influence); (c) sad on fear, sad on disgust, disgust on anger (incongruent–strong influence); and (d) disgust on sad (incongruent–weak influence).

Aligned face–body composites were created by seamlessly aligning the head with the body in a proportional, realistic-looking manner (see Figure 4A). As seen in Figure 4, we created three levels of misaligned stimuli by manipulating the horizontal distance between the face and the body. In the most distant, misaligned far condition, the face was displaced by a visual angle of ~6° (when viewed from 60 cm) and was separated by a notable gap from the right side of the body (Figure 4D). In the intermediate distance, misaligned near condition, the face was displaced by a visual angle of ~4° and appeared adjacent to the right side of the body with a minute gap (Figure 4C). In the most proximal misaligned connected condition, the face was displaced by a visual angle of ~2° and was physically and seamlessly attached to the shoulder (Figure 4B).

Design and procedure. A 2 (body congruency: congruent, incongruent) × 2 (body influence: strong, weak) × 4 (alignment: aligned, misaligned connected, misaligned near, misaligned far) within-participant design was used. Control bodiless faces and faceless bodies were included in a separate block and served to establish baseline recognition. Stimuli were randomly presented within blocks, and blocks were randomly ordered between participants. The instructions and procedure were similar to those in Experiment 1. Participants were instructed to categorize the emotion of the facial expressions using the response options of anger, sadness, disgust, and fear, which appeared on-screen below the image. However, unlike in Experiment 1, images appeared on-screen until a response was made. This change was induced because rapid presentation of the stimuli may not leave participants with enough time to actually fixate and process the body. By using an unlimited duration self-paced task, we increased the likelihood that regardless of the face–body distance, the entire stimuli would be processed.

Results

Baseline recognition of isolated faces and bodies. The mean recognition of faceless emotional bodies was 95.2 (SD = 13.7). Although the bodies were highly recognizable (anger, M = 100, SD = 0.0; disgust, M = 100, SD = 0.0; fear, M = 96.3, SD = 19.2; sadness, M = 85.12, SD = 36.2), an effect of body emotion was found, $F(3, 60) = 1.1$, $p > .30$, $\eta_p^2 = .10$, resulting from the fact that sad faces were less recognizable than both anger faces ($p < .05$) and disgust faces ($p < .05$). No other differences were significant (all ps > .30). The mean recognition of facial expressions without bodies was 54.6 (SD = 19.4). Sadness expressions (M = 72.9, SD = 17.5) were better recognized than disgust faces (M = 36.2, SD = 21.3), $t(26) = 6.4$, $p < .001$.

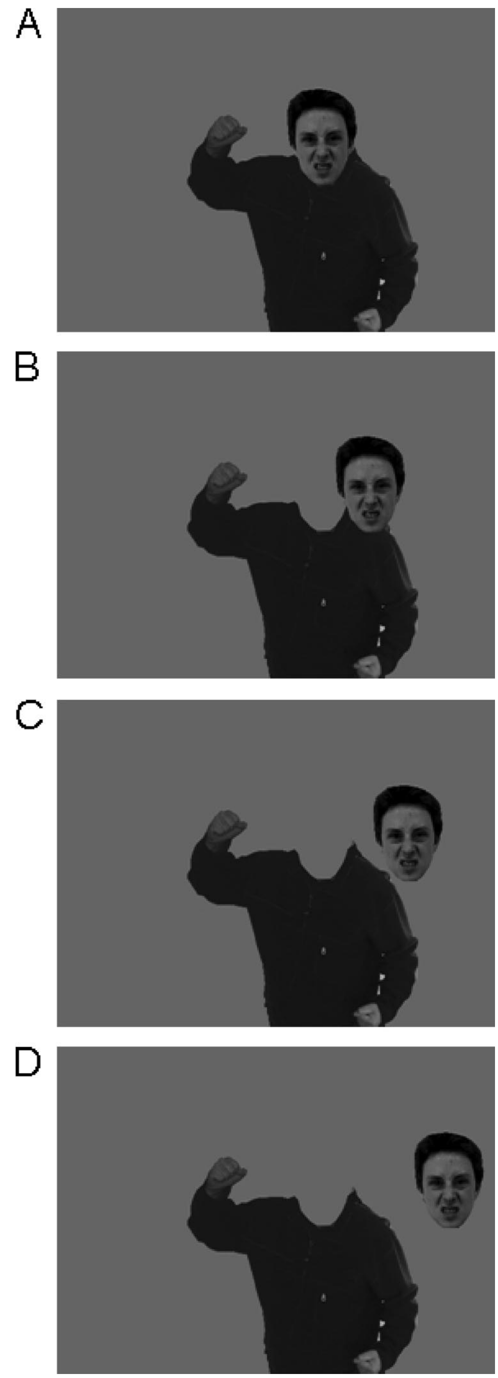

Figure 4. Examples of the levels of face–body alignment in Experiment 2. The levels are demonstrated with an incongruent face–body pair in which a disgust face is paired with an anger body: correctly aligned (A), misaligned connected (B), misaligned near (C), and misaligned far (D). Note that in Condition B the head and body are seamlessly connected albeit in a nonnatural form. Adapted with permission from *Moving Faces, Looking Places: The Amsterdam Dynamic Facial Expressions Set (ADFES)*, by S. T. Hawk, J. van der Schalk, & A. H. Fischer, 2008.

Assessing the impact of face–body misalignment. On the basis of independent results obtained when determining the strength of contextual influence in Experiment 1, the current face–body combinations were grouped into four categories: (a) congruent, strong influence (disgust faces on disgust bodies); (b) congruent, weak influence (sad faces on sad bodies); (c) incongruent, strong influence (disgust faces on anger bodies and sadness faces on fear and disgust bodies); and (d) incongruent, weak influence (disgust faces on sad bodies). As in Experiment 1, our dependent variable was obtained by calculating for each facial expression category a difference score by subtracting the baseline recognition of the face in isolation (i.e., face without body) from the recognition of the face in body context. With this difference score, positive values represent an increase in face recognition compared with baseline (i.e., compared with the face with no context), and negative values represent a decrease. To test whether the different levels of face–body alignment impacted face recognition, we subjected the difference scores to a 2 (body emotion: congruent, incongruent) × 2 (body influence: strong, weak) × 4 (alignment: aligned, misaligned connected, misaligned near, misaligned far) repeated measures ANOVA (see Figure 5).

A significant main effect was found for body congruency $F(1, 26) = 68.2$, $p < .001$, $\eta_p^2 = .72$, and a marginally significant effect was found for the body influence, $F(1, 26) = 3.9$, $p = .058$, $\eta_p^2 = .13$. The Body Congruency × Body Influence interaction was significant, $F(1, 26) = 23.9$, $p < .001$, $\eta_p^2 = .48$, as was the Body Congruency × Alignment interaction, $F(3, 78) = 29.4$, $p < .001$, $\eta_p^2 = .53$. Importantly, a three-way interaction emerged suggesting that the Alignment × Body Congruency effect was qualified by the strength of the body influence, $F(3, 78) = 2.3$, $p < .05$ (one-tailed), $\eta_p^2 = .08$. No other effects or interactions were significant (all Fs < 1).

We examined the three-way interaction with two Alignment × Body Congruency ANOVAs that were run for the strong and weak influence combinations. For the strong influence combinations, the Alignment × Body Congruency analysis showed a main effect of body congruency indicating that recognition was higher for congruent than incongruent stimuli, $F(1, 26) = 53.0$, $p < .001$, $\eta_p^2 = .67$, but no simple effect of alignment was found, $F(3, 78) = 0.22$, $p = .87$, $\eta_p^2 = .009$. Critically, a significant Alignment × Body Congruency interaction was found, $F(3, 78) = 24.0$, $p < .001$, $\eta_p^2 = .48$, indicating that although misalignment reduced recognition in congruent stimuli, it enhanced recognition in incongruent combinations.

Planned comparisons across the different levels of alignment confirmed that the recognition of congruent stimuli was higher for

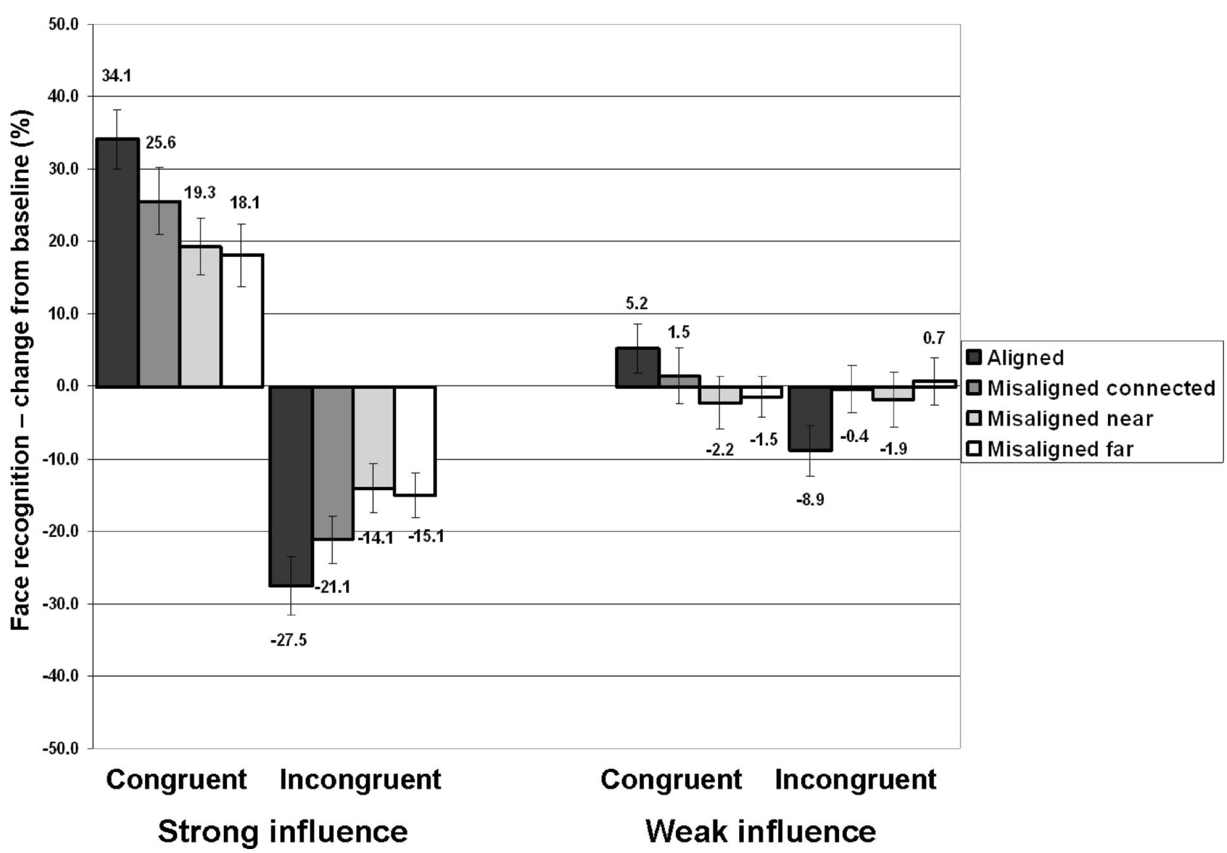

Figure 5. Mean recognition (and standard error) of facial expressions in congruent and incongruent body emotion as a function of the alignment between the face and the body and the strength of the body influence in Experiment 2. Mean recognition scores (and standard error) are expressed as difference scores compared with the baseline recognition of the face with no body. Higher scores reflect improved recognition compared with baseline, and lower scores reflect a decrease in recognition compared with baseline.

aligned versus misaligned connected stimuli, $t(26) = 2.6$, $p < .01$, and was marginally higher for misaligned connected versus misaligned near, $t(26) = 1.73$, $p < .09$. No difference was found between misaligned near and misaligned far, $t(26) = 0.34$, $p = .73$. Conversely, the recognition of incongruent stimuli was lower for aligned versus misaligned connected stimuli, $t(26) = 3.6$, $p < .001$, and lower for misaligned connected versus misaligned near, $t(26) = 4.1$, $p < .001$, but no difference was found between misaligned near and misaligned far stimuli, $t(26) = 0.63$, $p = .56$.

For the weak influence combinations, the Alignment × Body Congruency analysis found no effect of body congruency, $F(1, 26) = 0.78$, $p = .38$, $\eta_p^2 = .02$, and no effect of alignment, $F(3, 78) = 0.68$, $p = .56$, $\eta_p^2 = .02$. However, the Alignment × Body Congruency interaction was significant, $F(3, 78) = 5.4$, $p < .002$, $\eta_p^2 = .17$. Planned comparisons across the different levels of alignment showed that the recognition of congruent stimuli was not higher for aligned versus misaligned connected stimuli, $t(26) = 1.3$, $p = .19$, and was not higher for the misaligned connected versus misaligned near, $t(26) = 1.2$, $p = .23$, or for misaligned near versus misaligned far, $t(26) = 0.23$, $p = .81$. Recognition of incongruent stimuli was lower for aligned versus misaligned connected stimuli, $t(26) = 2.8$, $p < .008$, but no difference was found between misaligned connected and misaligned near, $t(26) = 0.47$, $p = .67$, or between misaligned near and misaligned far stimuli, $t(26) = 0.8$, $p = .39$.

Discussion

The main objective of Experiment 2 was to determine whether face–body distance and connectedness can account for our current findings as an alternative to holistic processing. Our results indicate that this is not the case. The influence of bodies on faces was always stronger when stimuli were aligned than misaligned, even when the face and body and body were located in proximity, indeed physically (mis)connected.

The results from manipulating the distance between the body and the face are important in several ways. First, they demonstrate that the composite effect we found cannot be explained as an artifact of the distance between the face and the body. Indeed, the near and far misalignment conditions yielded nearly identical data. The fact that the data did not show a gradual decline between these two conditions speaks against the possibility that eccentricity artifacts underlie the misalignment effect. Furthermore, although the connectedness of the face and body per se had a significant effect, the impact of the body in the connected misaligned condition was always reduced compared with the aligned condition. This indicates that the effect of misalignment reflects a true perceptual breakdown of holistic processing and not merely a breakdown of attentional capture characteristic of single objects.

Interestingly, with weak influence stimuli, the gradient between the misaligned connected and the other misaligned levels was obliterated. Furthermore, the difference between aligned congruent stimuli and misaligned connected stimuli was not significant. Nevertheless, incongruent aligned stimuli were less well recognized than misaligned stimuli. By contrast, in Experiment 1, the incongruent weak influence stimuli did not show such alignment effects. Although not central to the main question at hand, this difference may have resulted from changes in design and stimuli across the two experiments. In Experiment 1, the design fully crossed four body types by four face types, whereas in the current experiment we used a far more limited subset. Also, in the current experiment, stimuli appeared onscreen until a response was made, whereas in Experiment 1 the stimulus duration was limited to 1,000 ms. Therefore, the current design may have induced more conceptual emotional processing even when strength of the body on the face was weak. Nevertheless, this effect was reduced when the faces and bodies were misaligned and the person gestalt was broken.

Experiments 1 and 2 used face–body combinations to demonstrate an analogue of the classic composite face effect (Calder et al., 2000; Young et al., 1987). However, the original composite face design has been recently criticized for confounding perceptual factors with response bias and decisional factors (Richler et al., 2009, 2008). We next elaborate on this criticism and use a new and more powerful design recently proposed in the literature for testing composite face effects (Richler et al., 2011, 2008).

Experiment 3

For over 2 decades, the composite face effect has been considered the gold standard for holistic face processing. However, recent work has argued that the classic paradigm is not an ideal measure of perceptual holistic processing due to inherent elements of response bias from the unattended, irrelevant face half (Richler et al., 2011, 2008). In the classic design (also termed *partial design* by Richler et al., 2011), participants are presented with faces in which the upper and lower halves are taken from different identities. Participants then categorize a relevant face half, or judge whether two relevant face halves are same or different (for clarity and consistency, we will next assume these relevant halves are the upper face halves). Although the relevant upper face halves may be the same or different, the irrelevant lower face halves are always different. Presumably, the task-irrelevant, different lower face halves fuse holistically with the upper face halves, thus hindering the perceptual processing of the task-relevant face halves.

However, Richler et al. (2008) have argued that the fact that different lower parts are always used is problematic because they can induce a response bias to say "different" even if the upper (relevant parts) are perceived as the same and despite the fact that the lower parts are task irrelevant. Thus, it was argued, the composite face effect is not a clean perceptual measure. To overcome this shortcoming, these authors proposed a "complete design" by adding two additional conditions in which the irrelevant bottom halves are always the same and the relevant top halves may be same or different. Under this complete design, a 2 × 2 condition matrix is created with the following two factors: (a) trials may be defined as "same" or "different" depending on whether the task-relevant face halves are same or different, and (b) trials may be defined as "response congruent" or "response incongruent" depending on whether the correct response to the upper face parts corresponds to the response that would have been given to the irrelevant part. Hence, in the response congruent condition, both upper and lower halves of the face (albeit taken from different faces) lead to the same response (i.e., both lead to "same" responses or both lead to "different" responses). In the response incongruent condition, the upper face halves lead to one response (either “same” or “different”), and the lower parts would lead to the alternative response.

As in the partial design, the complete design presents the stimuli in two forms, aligned and misaligned. Unlike the partial design, a measure of sensitivity (d') between the matching in the same and different conditions is calculated separately for the response congruent and for the response incongruent trials in both the aligned and misaligned stimuli. Because misalignment disrupts holistic processing, a Response Congruency × Alignment interaction is expected demonstrating that the response congruency effect is larger in the aligned condition than in the misaligned condition. For a recent application and thorough description of the complete design, see Richler et al. (2011).

The critique of the classic composite effect also applies to our face–body design in Experiments 1 and 2. Specifically, it is hard to determine whether the influence of the body on the face is due to perceptual factors or to competition from the response that would have been given to the irrelevant body. To address this issue, we adapted the complete design to face–body stimuli and examined whether misalignment disrupts holistic processing. Following Richler et al.’s (2011) work, our main prediction was a Response Congruency × Alignment interaction showing that the main effect of response congruence (d' congruent $> d'$ incongruent) would be larger in the aligned condition than in the misaligned condition. Because our main interest was emotion perception, not identity perception, the task in a given trial was to determine whether two faces (which always differed in identity) conveyed the same or different emotions.

Our main aim was to tailor face–body combinations that would satisfy the required conditions of the complete design. To this end, we used, for each facial expression, a variety of face–body combinations with a range of contextual strength levels. Note that the calculation of d' for each facial expression is obtained via the performance with both same and different trials; hence, a neat separation of strong from weak context bodies was not practical, and all contextual strength levels were treated alike within a given face. If anything, the grouping of body pairs with stronger and weaker contextual influence should minimize the composite effects we were aiming to demonstrate.

Method

Participants. Twenty-three Princeton University students (14 female, nine male), mean age 18.7 years (range: 18–21). participated in the study for course credit or payment.

Stimuli. As in Experiment 1, facial expressions of 10 individuals were used, each posing prototypical facial expressions of disgust, sadness, anger, and fear. The 40 faces were combined with the four prototypical pictures of emotional bodies used in Experiment 1 conveying anger, disgust, sadness, and fear. Faces and bodies were fully crossed so that each facial expression category was paired with each body expression category. All face–body combinations appeared in both aligned and misaligned form. Figure 6 shows an example of a trial in which disgust faces appear on an anger body (left) and on a disgust body (right). Note that in all trials the two faces were always of different identity, regardless of whether they conveyed same or different emotions. For each facial expression, four matching pairs were used. The actual emotions of the face–body pairs used are outlined in Table 1. Since four facial expression categories were used and each included 10 face identities, the overall design included 160 pairs. These pairs could be aligned or misaligned, resulting in 320 trials altogether.

Design. To test for holistic perception of face–body combinations, we used a 4 (face: anger, sadness, disgust, fear) × 2 (alignment: aligned, misaligned) × 2 (response congruency: congruent, incongruent) within-participant design. Figure 7 outlines the generic design of the face matching task based on the complete design. The figure shows the different types of face–body pairs as a function of response congruency (congruent or incongruent), facial expression similarity (same or different), and alignment (aligned or misaligned). Note that the term *response congruency* used here differs from the term *body congruency* in the previous experiments. In Experiments 1 and 2, we used the term *body congruency* to express the fit or misfit between the emotional category of the face and body within a single specific face–body combination. By contrast, in the current experiment we show in each trial images of two people, and we use the term *response congruency* to express the fit or misfit between the response to the faces and the response to the bodies. In response congruent trials, both are “same” or both are “different,” whereas in the response

Figure 6. Example of a trial in the facial expression matching task, in the complete design of Experiment 3. The particular example shown depicts a “same” trial because the faces are both taken from the same disgust category. It is also an incongruent response trial because the response to the relevant faces (“same”) differs from the response that would have been given to the bodies (“different”). Adapted with permission from *Moving Faces, Looking Places: The Amsterdam Dynamic Facial Expressions Set (ADFES)*, by S. T. Hawk, J. van der Schalk, & A. H. Fischer, 2008.

Table 1
Pairs of Images Used in the Complete Design Paradigm of Experiment 3

	Same trials		Different trials	
Response congruency	Image 1	Image 2	Image 1	Image 2
Congruent				
Disgust	Disgust on disgust	Disgust on disgust	Disgust on disgust	Sadness on anger
Sad	Sadness on sadness	Sadness on sadness	Sadness on sadness	Anger on fear
Anger	Anger on anger	Anger on anger	Anger on anger	Fear on disgust
Fear	Fear on fear	Fear on fear	Fear on fear	Disgust on sadness
Incongruent				
Disgust	Disgust on disgust	Disgust on anger	Disgust on disgust	Sadness on disgust
Sad	Sadness on sadness	Sadness on fear	Sadness on sadness	Anger on sadness
Anger	Anger on anger	Anger on disgust	Anger on anger	Fear on anger
Fear	Fear on fear	Fear on sadness	Fear on fear	Disgust on fear

incongruent trials, the responses differ (e.g., faces are "same" but bodies are "different," and vice versa). Note that participants are never actually required to categorize the bodies; rather, we are referring to the evoked response conflict from the irrelevant bodies.

For example, consider the upper right cell in Figure 7. The facial expressions in two images are matched: Image 1 and Face Emo 1 on Body Emo 1 and Image 2 and Face Emo 3 on Body Emo 2. This is considered a "different" trial because the matched faces are taken from different emotions. However, the trial is response congruent because an identical response type is evoked by matching the faces and by matching the bodies (in both cases the response is "different"). By contrast, consider the lower right cell in which Face Emo 1 on Body Emo 1 is matched with Face Emo 3 on Body Emo 1. The trial is "different" because the matched faces are taken from different emotions. Additionally, the trial is response incongruent because the response to the faces is "different," whereas the response that would have been given to the bodies is "same."

Dependent measures. For each emotion, performance in the matching of face pairs was converted to d' scores. Separate d'

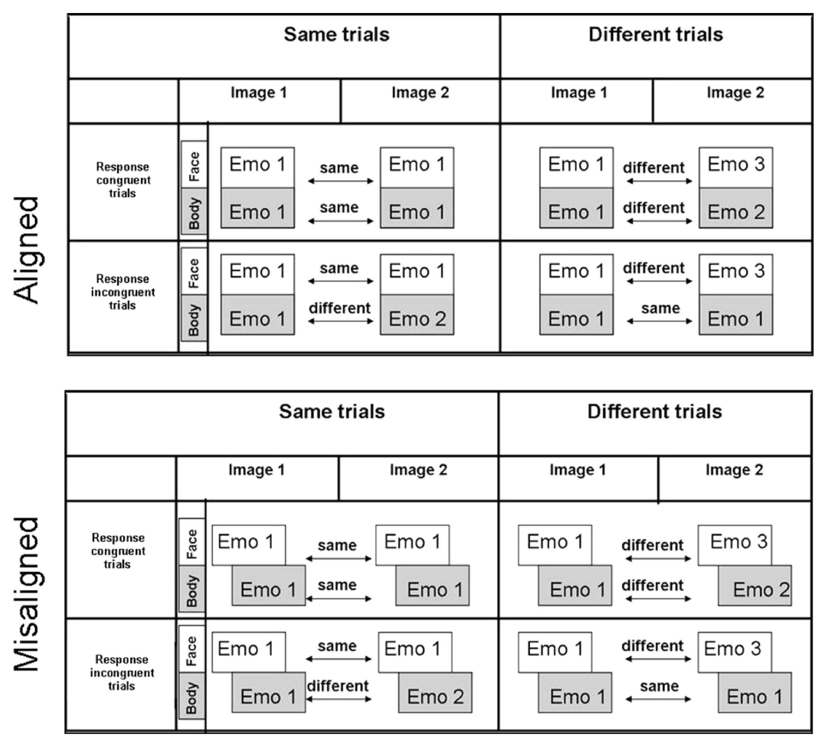

Figure 7. Schematic outline of the stimuli pairs used in the matching trials in Experiment 3. Pairs in each trial are defined as "same" or "different" depending on whether the relevant faces were indeed of same or different emotion (Emo). Pairs are defined as response congruent or response incongruent depending on whether the response to the irrelevant body is of the same type (i.e., "same" or "different") as the response to the face. All stimuli are repeated in aligned and misaligned form.

scores were obtained for aligned and misaligned face–body stimuli and were then submitted to the repeated ANOVA.

Procedure. In each trial, two pictures of different people appeared simultaneously on-screen. Participants were instructed to determine with "same" or "different" responses if the faces expressed the same or different emotion. Participants were told that the bodies are irrelevant to the matching task. The images remained on-screen for 2,000 ms, after which participants were prompted to respond with "same" or "different" options. No duration limit was imposed for responses. The predefined stimuli pairs were presented at random order, and images were randomly selected to appear on the right or left within each pair.

Results. The d' values were submitted to a 4 (face: anger, sadness, disgust, fear) $\times$ 2 (response congruency: congruent, incongruent) $\times$ 2 (alignment: aligned, misaligned) repeated ANOVA. A main effect of the face was found indicating that matching accuracy was higher for some face emotions more than others, $F(3, 66) = 14.8$, $p < .001$, $\eta_p^2 = .40$. Paired t tests found that anger ($M = 1.34$, $SD = 0.62$) and fear faces ($M = 1.43$, $SD = 0.63$) had higher d' values than disgust ($M = 0.83$, $SD = 0.65$) and sad faces ($M = 0.82$, $SD = 0.63$; all ps $< .001$), but no differences were found between anger and fear or between disgust and sad faces (all ps $> .30$). As expected, a main effect of congruency indicated that response congruent pairs ($M = 1.4$, $SD = 0.7$) were better matched than response incongruent pairs ($M = 0.75$, $SD = 0.9$), $F(1, 22) = 51.4$, $p < .001$, $\eta_p^2 = .70$. The main effect of alignment was not significant ($F < 1$).

Most importantly, a Response Congruency $\times$ Alignment interaction was found showing that the congruence effect (d' congruent $> d'$ incongruent) was larger in the aligned conditions than in the misaligned condition, $F(1, 22) = 35.2$, $p < .001$, $\eta_p^2 = .61$. The face emotion did not interact with the alignment ($p > .40$), the response congruency ($p > .08$), or the Alignment $\times$ Response Congruency interaction ($p > .70$). Therefore, we simplified the analysis by grouping the different emotion categories and followed up the significant Alignment $\times$ Response Congruency interaction with planned comparisons (see Figure 8). Paired t tests confirmed that in aligned stimuli the d' for response congruent stimuli was higher than the d' for response incongruent stimuli, $t(22) = 7.3$, $p < .001$. However, in the misaligned stimuli, the difference between d' for response congruent and response incongruent stimuli did not reach significance, $t(22) = 1.8$, $p > .08$. Furthermore, d' values for response congruent stimuli were higher in the aligned than in the misaligned stimuli, $t(22) = 4.9$, $p < .001$. Conversely, d' values for response incongruent stimuli were lower in the aligned than in the misaligned stimuli, $t(22) = 4.6$, $p < .001$.

Although the three-way Face $\times$ Response Congruency $\times$ Alignment interaction was not significant, the Response Congruency $\times$ Alignment interaction was significant within each facial expression when tested individually (all Fs > 7). Specifically, for each of the facial expressions, the congruent versus incongruent difference was larger for aligned than for misaligned stimuli: disgust, $p < .001$; anger, $p < .001$; sadness, $p < .001$; and fear, $p < .04$.

Discussion

The converging results from Experiment 3 replicate the basic findings from Experiments 1 and 2 and demonstrate that faces and bodies are holistically perceived as a unit. Experiment 3 adds crucial validity to our prior results. Most importantly, we used the complete design paradigm that includes performance in congruent and incongruent response conditions (Richler et al., 2011). This approach has a major advantage because it overcomes the inherent confound of response competition that manifests in the classic partial design. The fact that similar results emerged in all three experiments indicates that our results in Experiments 1 and 2 did not merely rise due to response competition from the incongruent bodies. Rather, the bodies actually integrate with the face and induce a genuine perceptual holistic effect. This holistic effect can be reduced with a relatively small misalignment of the face and body that breaks the gestalt, a finding replicated across all three experiments.

Experiment 3 included an additional advantage over Experiments 1 and 2 because facial expressions were not categorized individually but rather matched for emotion in a simultaneous presentation paradigm. The fact that facial expressions appeared

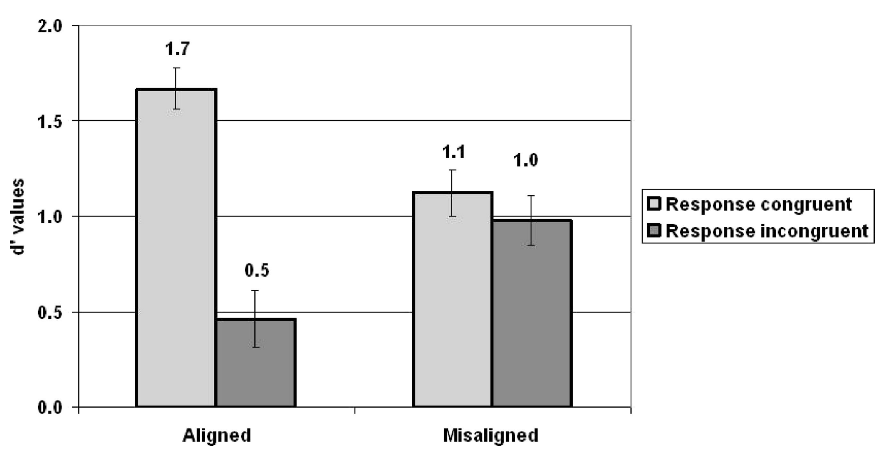

Figure 8. Performance in the matching task in Experiment 3 expressed as d' values (and standard error) as a function of alignment and congruency. Although the body congruency had a significant effect on the face matching, the influence of the body was greatly reduced when the faces and bodies were misaligned, indicating a fracture of the person gestalt.

simultaneously could have allowed participants to match the emotions based on low-level musculature movements, thereby minimizing any influence of the body. Nevertheless, participants were strongly influenced by the bodies, and this effect was strongest when the bodies and faces were ecologically aligned. By contrast, a misalignment of the face and body resulted in a breakdown of holistic processing and reduced the impact of the bodies on the faces.

General Discussion

What is the ecological unit of human social perception? Most studies to date have focused on isolated body parts, such as the face (Maurer et al., 2002) or body (Peelen & Downing, 2007), both of which convey important social and affective information. Although it is known that information from the body may influence face recognition (Aviezer, Hassin, Ryan, et al., 2008; Meeren et al., 2005), previous studies have not demonstrated that the face and body may bind to form a unitary perceptual gestalt.

Our findings, replicated in three experiments, suggest that humans process faces and bodies as a single person unit. In other words, the perceptual system does not merely code information from the face and body separately and then compute a weighed output (Ekman et al., 1982; Meeren et al., 2005; Wallbott, 1998). Rather, the combined face and body create a synergistic effect that may boost or impede face recognition depending on the congruency between the two sources, and depending on the strength of the contextual effect in the specific face–body combination.

As shown for faces, the gestalt of the person unit is highly dependent on the ecological form of the stimuli. Just as the holistic perception of the face is fractured when the upper and lower part are spatially misaligned (Young et al., 1987), so is the perception of the person when the face and the body are misaligned.

Perhaps the most direct comparison to our current composite task is the composite emotional face task, introduced by Calder et al. (2000). In that paradigm, participants were presented with composite faces created from two halves, say, an upper disgust face half paired with a lower fearful face half. Participants were required to categorize one half while effectively ignoring the other. Under this paradigm, it has been found that participants were slower and marginally less accurate at categorizing face halves when the two halves were aligned compared with when they were horizontally misaligned (Calder et al., 2000). In that sense, our current composite person results are even more robust, as misalignment of strong influence face–body combinations systematically altered the recognized face emotion, not merely the time required for categorization.

In the current set of experiments, the body does not usually appear in isolation (except for the anger bodies); rather, it is embedded in a naturalistic situational context (gun, gravestone, etc.). This intentional confound is ecological by nature, and indeed some body expressions (e.g., disgust) are difficult to convey without paraphernalia. Interestingly, the influence of affective scenes and paraphernalia with no bodies on facial expression categorization is relatively modest (Righart & de Gelder, 2008), implying that the body plays a key role in the influence process, even when additional paraphernalia are present. It is important to stress, however, that the affective scenes and paraphernalia were available whether the face and body were aligned or misaligned; hence, our major argument for holistic processing of the face and body remains unaffected, regardless of the exact nature of the body context.

Classical models consider emotion recognition as a summary of information from available features (Ellison & Massaro, 1997; Wallbott, 1998). By contrast, our findings indicate that the physical composition of the face with the body is an important factor in the perceptual processing of people. Although the same information is available when the face and body are aligned and misaligned, the physical separation is sufficient to break the gestalt and reduce the influence between body and face. Furthermore, even when the face and body were physically connected but in an incorrect manner, the body-to-face influence was significantly reduced.

Using the complete design proposed by Richler et al (2008), we were able to show that the influence of the body on the face and its breakdown is not merely an artifact of response bias, but rather it includes an effect of holistic perception. This was shown with an emotion matching design in which the response that would have been elicited by the irrelevant bodies may be congruent or incongruent with the response to the relevant faces. This design allows one to obtain a true matching sensitivity score and examine whether the perception changes as a function of alignment. This influential and powerful design has recently been used in several studies (Gao, Flevaris, Robertson, & Bentin, 2011; Richler et al., 2011, 2008, 2009) and is rapidly replacing the more traditional composite task. Hence, it is important that the face–body composite effect withstands both traditional and more stringent contemporary tests.

The potential importance of unitized face–body perception seems straightforward. In real-life conditions, social and emotional information may be impoverished, and combining data from all available information is crucial. As the perceptual system develops an expertise for viewing the whole person, the most ecological approach would be to view the face and body as a unit (McArthur & Baron, 1983). Although we introduced incongruent face–body combinations as a tool for exploring the holistic binding mechanism, we suspect that in realistic situations the information flowing from the face and body may be far more complex and challenging. For example, the face and body may express highly ambiguous (even if congruent) emotions, in a manner, leading to potential bidirectional confusion. In other events, face–body conflicts may arise when an individual attempts to mask an emotion by putting on a particular facial expression while failing to control for "emotional leakage" from the body (Ekman, 2003).

What might be the implications of integrated face–body processing for real-life emotion recognition? Although the relation between classic holistic face processing and normal face recognition has been debated (Konar, Bennett, & Sekuler, 2010), more recent work using the complete design has shown that the two are indeed correlated (Richler et al., 2011). To the extent that holistic person processing is analogous to holistic face processing, we would expect the two capacities to be correlated. Furthermore, individuals who display robust holistic perception of the person unit may also be skilled at recognizing emotional expressions in isolation.

We further speculate two maladaptive patterns of face–body perception. At one extreme, individuals may focus on the target face while completely disregarding the contextual information from the body. Although such a strategy may formally result in high accuracy, such a pattern would prove inefficient and maladaptive, as the contextual information may be crucial for correctly deciphering the affective situation. Alternatively, an additional maladaptive pattern may present with indiscriminate holistic processing that may suggest maladaptive overcontextualizing. Individuals with indiscriminate holistic processing may display strong integration and contextual bias in otherwise weak influence face–body pairs. For example, though most viewers would not show contextual influence from a fearful body to a disgusted face, individuals with indiscriminate holistic perception would show strong contextual influence in such cases. Although variations of such patterns have been demonstrated in neuropsychological case studies (Aviezer, Hassin, & Bentin, 2011), the prevalence of such patterns in healthy versus psychiatric populations is unknown.

For reasons of methodological practicality the current study focused on emotional face–body composites; however, we suspect that holistic person processing is a more general phenomenon. Although research in faces initially indicated that face identity composites are processed holistically (Young et al., 1987), this finding was later extended to numerous face dimensions including expression (Calder et al., 2000), gender (Baudouin & Humphreys, 2006), race (Michel et al., 2006; Tanaka, Kiefer, & Bukach, 2004), attractiveness (Abbas & Duchaine, 2008), and social judgments (Todorov et al., 2010). In theory, emotional stimuli could induce a unique processing mode that would not extend to other face dimensions. However, we doubt this is the case, and we expect that face–body composites of other social dimensions (e.g., gender, identity, attractiveness, dominance, age) would also be processed holistically, and hence would be susceptible to misalignment effects.

Since its introduction, a multitude of studies have used the composite face effect as a measure for investigating the holistic processing of isolated human parts such as faces (Young et al., 1987) and bodies (Reed et al., 2003). By taking a broader perspective, we show that holistic processing may extend to the whole-person level and is disrupted when the ecological face–body gestalt is broken.

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