

# Bidirectional Contextual Influence Between Faces and Bodies in Emotion Perception

Maya Lecker

The Hebrew University of Jerusalem

Ron Dotsch

Utrecht University

Gijsbert Bijlstra

Radboud University

Hillel Aviezer

Hebrew University

Recent evidence shows that body context may alter the categorization of facial expressions. However, less is known about how facial expressions influence the categorization of emotional bodies. We hypothesized that context effects would be displayed bidirectionally, from bodies to faces and from faces to bodies. Participants viewed emotional face–body compounds and were required to categorize emotions of faces (Condition 1), bodies (Condition 2), or full persons (Condition 3). Results showed evidence for bidirectional context effects: faces were influenced by bodies, and bodies were influenced by faces. However, because the specific confusability patterns differ for faces and bodies (e.g., disgust and anger expressions are confusable in the face, but less so in the body) we found unique patterns of contextual influence in each expression channel. Together, the findings suggest that the emotional expressions of faces and bodies contextualize each other bidirectionally and that emotion categorization is sensitive to the perceptual focus determined by task instructions.

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For many years the field of emotion perception has largely focused on isolated facial expressions, ignoring their accompanying context. This decontextualized isolated-face approach seemed appropriate as basic emotional expressions were considered prototypical and discrete signals (Smith, Cottrell, Gosselin, & Schyns, 2005) that are accurately recognized, irrespective of context (Buck, 1994; Ekman, Friesen, & Ellsworth, 1982; Ekman & O'Sullivan, 1988; Nakamura, Buck, & Kenny, 1990).

Recently, researchers have shown increased interest in the surrounding context, showing that it may significantly affect the recognition of facial expressions (for reviews see, Gendron, Mesquita, & Barrett, 2013; Wieser & Brosch, 2012). One prominent context with which the face typically appears is the body, and similar to the face, the body may express emotions. Indeed, accumulating evidence has indicated that an incongruent body context can alter the early neural processing (Meeren, van Heijnsbergen, & de Gelder, 2005), fixations, and behavioral categorization of pro-

typical facial expressions (Aviezer, Hassin, Ryan, et al., 2008; Aviezer, Trope, & Todorov, 2012b; Van den Stock, Righart, & de Gelder, 2007).

Additional work shows that facial and bodily emotional cues are seamlessly integrated into a single percept, which is processed automatically (Aviezer, Bentin, Dudarev, & Hassin, 2011) and holistically (Aviezer et al., 2012b; Mondloch, 2012; Mondloch, Nelson, & Horner, 2013). To take an example, a prototypical disgust face matched with an angry body context is often classified as conveying anger (Aviezer et al., 2012b). Such categorization shifts are strongest when the presented face and the body-predicted face expression are most similar (e.g., anger and disgust are perceptually similar). However, interference from incongruent bodies occurs with additional face–body combinations such as fear and anger (Meeren et al., 2005). Together, these and other findings highlight the perceptual malleability of the facial expression and cast doubt on its invariant diagnostic signal value (Hassin, Aviezer, & Bentin, 2013).

As noted, previous work has usually taken a face-centric approach. That is, the majority of the recent studies defined the face as the target and examined how contextual body information interferes with its recognition. However, the decision on what serves as target and what serves as context is arbitrary. One can just as easily imagine that the body, as target, may be altered by the contextual influence of the accompanying facial expression. While some of the aforementioned studies downplayed the diagnostic qualities of the face, they may have overemphasized the diagnostic

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Maya Lecker, Psychology Department, The Hebrew University of Jerusalem; Ron Dotsch, Psychology Department, Utrecht University; Gijsbert Bijlstra, Behavioral Science Institute, Radboud University; Hillel Aviezer, Psychology Department, Hebrew University.

Correspondence concerning this article should be addressed to Maya Lecker, Psychology Department, The Hebrew University of Jerusalem, Mount Scopus, Jerusalem 9190501, Israel. E-mail: [maya.lecker@mail.huji.ac.il](mailto:maya.lecker@mail.huji.ac.il)

qualities of the contextual body (Aviezer et al., 2012b; de Gelder, 2006; Lecker, Shoval, Aviezer, & Eitam, 2017; Van den Stock et al., 2007). Although recent studies have advanced standardized sets of stereotypical emotional bodies (de Gelder & Van den Stock, 2011; Thoma, Soria Bauser, & Suchan, 2013), these body stimuli, like faces, may also display inherent ambiguity and susceptibility to contextual influence.

In fact, recent work has demonstrated that the influence between faces and their context is bidirectional (Hess, Landmann, David, & Hareli, 2018). Hess and colleagues presented participants with moral violation vignettes alongside facial expressions of people who were presumably witnessing and reacting to these events. Participants rated both the emotional reactions observed and their own moral appraisal of the situation described. In line with a bidirectional influence account, situational context influenced how emotional reactions to this context were rated and in turn, the emotional expressions presumably reacting to the situation influenced the appraisal of the situation. Although that study did not examine face–body effects, it offers conceptual evidence supporting bidirectional face–body effects.

Kret, Stekelenburg, Roelofs, and de Gelder (2013) were the first to directly investigate the bidirectional influence of emotional faces and bodies. In that study (Experiment 2) the investigators first examined the influence of emotional body context on facial expressions. Faces and bodies expressing happiness, anger, and fear were combined in a fully crossed design, and participants were requested to categorize the faces while the bodies served as context. As predicted, anger and fear faces were better recognized when presented with congruent than incongruent bodies. They then continued to examine the reverse task and requested participants to categorize the bodies while the faces served as context. Interestingly, although the happy bodies were better recognized with congruent than with incongruent faces, such a congruency effect was not observed for the angry or fearful bodies.

While promising, the results of Kret et al. (2013) raise some important questions. First, they suggest an asymmetry in which faces are more influenced by body context than vice versa. While tempting, this conclusion may be preliminary due to the extremely high recognition rates of stimuli in their study (specifically, the angry and fearful bodies were recognized at ceiling irrespective of face context). Relatedly, only three emotion categories were given to participants, from which only two were negative (anger and fear). Context effects flourish under ambiguity (e.g., Aviezer, Trope, & Todorov, 2012a), and may diminish when performance is at ceiling. Enlarging the response set and using a range of stimuli with higher natural confusability (e.g., anger and disgust) may increase ambiguity, and influence the shifts in categorization of facial and body expressions.

Lastly, in Kret et al.'s (2013) study the recognition of each target stimulus (face or body) was conducted while the contextual stimuli (face or body) was a task-irrelevant, ignored stimulus. This common approach (e.g., Aviezer, Hassin, Ryan et al., 2008; Meeren et al., 2005; Noh & Isaacowitz, 2013) is useful for examining the automatic influence of the task irrelevant channel, but it does not allow us to determine if bidirectional context effects still occur under natural viewing conditions, that is, without a defined target focus.

In order to overcome the aforementioned limitations, our aims in the present study were threefold. First, we wanted to establish and

examine the relative potency of bidirectional context effects between emotional faces and bodies. This would allow us to directly compare the influence of faces on categorizing bodies with the influence of bodies on categorizing faces, in one design. Importantly, we aimed for a larger set with natural confusability (e.g., inclusion of disgust and anger) in order to avoid the ceiling effects in prior work.

Some researchers have argued that bodies convey broad affective states in contrast to faces that convey specific emotions (Ekman & Friesen, 1967). If so, faces may be more resilient than bodies to context effects because they convey more specific information. By contrast, more recent work has demonstrated that similar to faces, body expression and body language can successfully convey specific emotions (e.g., De Gelder, 2009; de Gelder & Van den Stock, 2011; Thoma et al., 2013). This account would predict more symmetrical context effects between faces and bodies.

Our second aim was to deepen our understanding of contextual influence by examining the role of confusability between emotional expressions in predicting context effects. Confusability among faces can be well characterized in terms of perceptual similarity (e.g., which expressions share similar action units). However, less is known about the confusability among emotional bodies. If confusability occurs at a deep conceptual level (i.e., because the emotions are conceptually similar), we would expect to detect symmetrical patterns of confusion irrespective of the target channel being the face or body. Thus, if a disgusted face with an angry body is judged as conveying facial anger, then a disgusted body with an angry face should be judged as conveying bodily anger.

On the other hand, confusability might be more superficial, and based on perceptual similarity. If this is the case, we may expect to find different emotion-specific patterns in each channel because perceptual similarity patterns in emotion categorization differ for faces and bodies. For example, in contrast to disgust and anger bodies, disgust and anger faces are highly similar (Susskind, Littlewort, Bartlett, Movellan, & Anderson, 2007). Hence, disgust faces may appear angry under the influence of contextual angry bodies, but angry bodies would appear less disgusted under the influence of contextual disgust faces. Likewise, in contrast to disgust and fearful faces, disgust and fearful bodies are highly similar, as both display extended defensive-like hands (Thoma et al., 2013). Hence, disgust bodies may appear fearful under the influence of a fearful face, but disgust faces would not appear fearful under the influence of fearful bodies. In short, the confusability role in the categorical shift for bodies and faces may reveal if the shift is based on a conceptual or perceptual confusability.

Finally, our third aim was to examine if bidirectional contextual effects between faces and bodies still occur under free viewing conditions when the task does not prioritize categorization of the face or body. On the one hand, recognition may be based exclusively on the face, especially in Western culture (Masuda et al., 2008) and even when faces and bodies are equally salient and well recognized, as people may expect faces to be more revealing (De Gelder, 2009). On the other hand, emotions from the body may also infiltrate emotion recognition processes, especially when facial expressions are ambiguous (Aviezer, Hassin, Bentin, & Trope, 2008).

## Method

### Participants

One hundred and 23 MTurk workers (67 males, 56 females, average age: 34.9 years,  $SD = 9.7$  years), received \$2.50 for their participation in the experiment. The majority of participants reported English as their mother tongue (91%), and the remainder reported Tamil, Hindi, or Romanian. Participants were randomly assigned to one of three conditions in which they were required to categorize the emotion of the body (Condition 1,  $n = 44$ ), the emotion of the face (Condition 2,  $n = 41$ ), or the emotion of the full person (Condition 3,  $n = 38$ ).<sup>1</sup> Based on previous online emotion perception experiments in our lab we estimated that 35–40 participants per condition are required to have 80% power to detect a medium strength effect size. The study was approved by the Hebrew University Ethics committee.

### Data Quality Assertion

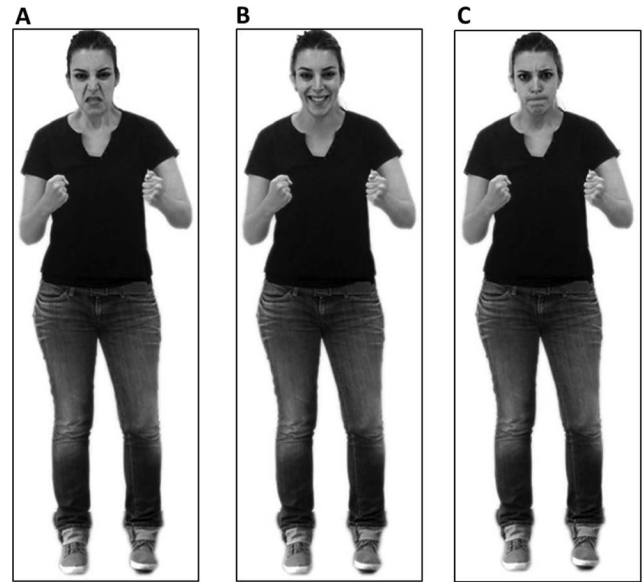
To ensure the quality of the MTurk data, two measures were used. First we used the performance of isolated facial expression recognition as it has well-established norms and set the a-priori exclusion criterion at  $Z = -2.5$ . Subsequently, we excluded four participants scoring  $Z = -2.66$ . Second, we examined the overall duration of task completion task, and set the a-priori exclusion criterion at  $Z = -2.5$ . Specifically, we searched for participants who completed the task extremely rapidly, suggesting low attentiveness to the stimuli or poor compliance with the task. The mean duration was 22.45 ( $SD = 11.5$ ) minutes and no participant reached the  $Z = -2.5$  cutoff criteria.

### Stimuli

Facial expressions of six individuals (3 female) posing the basic facial expressions of anger, disgust, fear, and happiness, were selected from the validated Amsterdam Dynamic Facial Expression Set (ADFES; Van Der Schalk, Hawk, Fischer, & Doosje, 2011). These faces were combined with body expressions of six individuals posing happiness, anger, disgust, and fear selected from the Bochum Emotional Stimulus Set (BESST; Thoma et al., 2013), see Figure 1 for illustration. For each emotion, the selected bodies were the ones which achieved the highest accuracy rates in the original set. Together, the entire set consisted of 96 stimuli (6 unique exemplars per each body–face combination). All stimuli were unique (i.e., for each identity, each emotion combination appeared only once). Emotional bodies and faces were converted to greyscale and realistically combined using Photoshop CC, in a fully crossed design. Isolated bodies and faces from the original sets were presented to participants as well, in order to create an emotion recognition baseline.

### Procedure

Body–face combinations were randomly presented on a computer monitor, one at a time, in a free viewing manner. Depending on their condition assignment, participants were requested to choose the emotion that best described the facial expressions (Condition 1), the bodily expressions (Condition 2), or the full



**Figure 1.** Stimuli examples: The body in all images portrays an angry expression combined with (A) a disgusted face, (B) a happy face, and (C) an angry face. All facial expressions were obtained from the ADFES set (Van Der Schalk, Hawk, Fischer, & Doosje, 2011), and all body expressions were taken from the BESST set (Thoma, Soria Bauser, & Suchan, 2013). The identity of the body expression was consistently paired with the same identity of the facial expression, for all combinations.

person expression (Condition 3) from a list of four emotional labels (happiness, anger, disgust, and fear) presented below the image. Following the experimental block, participants were presented with isolated faces and bodies, in random order, and were asked to identify the emotion that best described each stimulus from the four options. This block was presented second to avoid contaminating our main experimental block with any memory or practice effects. Stimuli were presented until response in order to increase, as much as possible, target accuracy rates. Thus, evidence for integration (i.e., a reduction in accuracy rates in incongruent trials) could not be explained as an artifact of the rapid presentation. While extended presentation time may differ from real-life social interactions, our main aim was to demonstrate proof of concept for bidirectional face–body integration. De facto, the average time for a participant to complete the study was ~22 min ( $SD \sim 11$  min), and the average time per a single trial was 9.1 seconds.

### Analysis Strategy

When participants are instructed to categorize the face or the body, objective “accuracy” and “error” scores may be assigned to body or facial expression recognition. However, these measures are not applicable when classifying the full person, because responses corresponding to either the face or body may both be deemed accurate. Therefore, the “full person” condition was analyzed separately by comparing the probability of categorizing

<sup>1</sup> Due to a technical error, the number of participants in each condition is uneven.



incongruent versus congruent combinations, which allowed us to assess the impact of the body on the face, and the impact of face on the body. We elaborate more on this analysis strategy later on. Throughout the paper, results were analyzed with ANOVAs followed up with Bonferroni corrected *t* tests.

## Results

### Isolated Facial and Body Expression Recognition

Prior to testing the recognition of composite face-body stimuli, we analyzed, across all groups, the recognition of emotional bodies and faces presented alone. A significant effect indicated that isolated faces ( $M = .89$ ,  $SD = .10$ ) were better recognized than isolated bodies ( $M = .81$ ,  $SD = .11$ ),  $F(1, 118) = 56.0$ ,  $p < .001$ ,  $\eta_p^2 = .32$ , see Table 1 for accuracy and error Means and *SD*s. Thus, based on their recognition in isolation, facial expressions should be slightly more resilient than bodies to contextual effects (for the full ANOVA and breakdown of the isolated baseline stimuli by emotion and group, see the online supplementary material).

As can be seen in Table 1, although most stimuli were well recognized, the recognition of disgust bodies was lower than anticipated as they were confusable with fear bodies. This specific confusability pattern is also evident (albeit to a lower extent) in the original set norms (Thoma et al., 2013). Thus, it seems that the confusability between disgust and fear bodies is inherent to the stimuli, possibly reflecting a natural ambiguity between protective hand movements from a revolting or dangerous entity, respectively. Nevertheless, as our aim was to examine bidirectional contextual effects in face body composites, we address and analyze the possible impact of the disgust bodies by conducting our analyses on the entire stimulus set, as well as conducting analyses while excluding the disgust stimuli.

### Examining Bidirectional Context Effects

**The impact of contextual bodies on facial expression categorization.** In order to test if bodies influenced the categorization accuracy of facial expressions during the face categoriza-

tion task, A 4 (Face emotion: anger, disgust, fear, and happiness)  $\times$  4 (Body emotion: anger, disgust, fear, and happiness) repeated-measures ANOVA was conducted on the facial accuracy scores. As seen in Figure 2, A significant effect of the face was found,  $F(3, 117) = 41.2$ ,  $p < .001$ ,  $\eta_p^2 = 0.51$ , indicating that some facial expressions were better recognized than others. Importantly, the contextual body had a significant effect on facial expression recognition,  $F(3, 117) = 21.02$ ,  $p < .001$ ,  $\eta_p^2 = 0.35$ , and a significant interaction indicated that the categorization of faces was differentially influenced depending on the specific body with which it was paired,  $F(9, 351) = 71.28$ ,  $p < .001$ ,  $\eta_p^2 = 0.65$ .

We then followed the significant interaction, by analyzing for each facial expression separately the effect of different body expressions on accuracy. For all facial expressions this effect was significant (Angry faces:  $F(3, 117) = 85.1$ ,  $p < .001$ ,  $\eta_p^2 = 0.69$ ; Disgust faces:  $F(3, 117) = 89.4$ ,  $p < .001$ ,  $\eta_p^2 = 0.70$ ; Fear faces:  $F(3, 117) = 66.1$ ,  $p < .001$ ,  $\eta_p^2 = 0.63$ ; Happy faces:  $F(3, 117) = 18.9$ ,  $p < .001$ ,  $\eta_p^2 = 0.37$ ), showing that accuracy rates of all faces were influenced by the body context, albeit to different degrees. Planned comparisons for each facial expression between congruent and incongruent combinations (collapsed across incongruent body emotion) confirmed a significant congruency effect for all facial expressions (all *p* values  $< .001$ , all Cohen's *ds*  $> 0.73$ , see Figure 2).

Overall, incongruent bodies resulted in a reduction in face accuracy and a tendency to classify the face as conveying the body emotion (see also online supplementary material for a detailed description of the contextual influence and error analysis). As found in previous work (Aviezer et al., 2008), the magnitude of contextual influence depended on the specific matching between emotional faces and bodies, but no facial expression category was immune to body context. Furthermore, a tendency to classify the faces as conveying the body emotion was found, see error analysis in the online supplementary material and online supplementary Figure S1.

**The impact of contextual faces on body expression categorization.** In order to test if faces influenced the categorization accuracy of bodies, a 4 (Face emotion: anger, disgust, fear, and happiness)  $\times$  4 (Body emotion: anger, disgust, fear, and happiness) repeated-measures ANOVA was conducted on the body accuracy scores. A significant effect of the Body expression was found indicating that some bodies were better recognized than others  $F(3, 126) = 37.8$ ,  $p < .001$ ,  $\eta_p^2 = .47$ . Furthermore, a significant effect of the Face on body accuracy was found, indicating an overall context effect,  $F(3, 126) = 4.9$ ,  $p < .01$ ,  $\eta_p^2 = .12$  and a significant interaction indicated that categorization of emotional bodies was differentially influenced by the specific combination of facial expressions with which they were paired,  $F(9, 378) = 17.8$ ,  $p < .001$ ,  $\eta_p^2 = .30$ .

We followed up the interaction with separate one-way ANOVAs for each body expression, assessing the effect of the facial context on the accuracy of each body expression. As in the case of faces, all body expressions were influenced by the incongruent faces: Angry bodies:  $F(3, 126) = 13.8$ ,  $p < .001$ ,  $\eta_p^2 = .25$ ; Disgust bodies:  $F(3, 126) = 19.64$ ,  $p < .001$ ,  $\eta_p^2 = .32$ ; Fear bodies:  $F(3, 126) = 15.59$ ,  $p < .001$ ,  $\eta_p^2 = .27$ ; and Happy bodies:  $F(3, 126) = 13.39$ ,  $p < .001$ ,  $\eta_p^2 = .24$ . Planned comparisons confirmed that the difference in accuracy between congruent and incongruent combinations (pooled across different incongruent

Table 1  
Accuracy and Error Rates for Isolated Faces and Bodies

Isolated target	Emotion label choice			
	Anger	Disgust	Fear	Happiness
<b>Faces</b>				
Anger	<b>.85 (.20)</b>	.10 (.15)	.03 (.09)	.01 (.002)
Disgust	.18 (.19)	<b>.79 (.21)</b>	.02 (.09)	.00 (.00)
Fear	.02 (.05)	.06 (.11)	<b>.92 (.12)</b>	.00 (.02)
Happiness	.00 (.00)	.001 (.01)	.00 (.00)	<b>.99 (.01)</b>
<b>Bodies</b>				
Anger	<b>.96 (.11)</b>	.01 (.05)	.00 (.03)	.017 (.06)
Disgust	.01 (.04)	<b>.51 (.32)</b>	.46 (.32)	.01 (.04)
Fear	.02 (.05)	.14 (.17)	<b>.81 (.19)</b>	.02 (.05)
Happiness	.04 (.09)	.001 (.01)	.004 (.02)	<b>.95 (.1)</b>

*Note.* Means and *SE* were computed across the three experimental groups. For each emotional target, the mean correct categorizations (in bold) and the errors (i.e., labeling other emotions than the target) are presented. *SD* appears in parentheses. Results are presented across all three conditions.

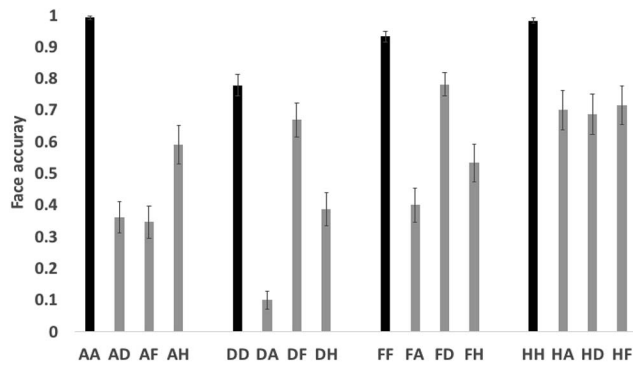


Figure 2. Mean accuracy (and *SE*) while categorizing facial expressions with congruent body expressions (black bars) and incongruent body expressions (gray bars). A = Anger, D = Disgust, F = Fear, H = Happy. The first letter denotes the face emotion and the second letter denotes the body emotion (e.g., AD = anger face with disgusted body).

faces) was significant for all body expressions (all  $p$  values  $< .001$ , all Cohen's  $d > .62$ , see Figure 3).

Overall, incongruent faces resulted in a reduction in body accuracy, which depended on the specific matching between emotional faces and bodies. Furthermore, a tendency to classify the body as conveying the face emotion was found, see error analysis in the [online supplementary material](#) and [online supplementary Figure S2](#).

**Comparing the susceptibility to context effects in faces versus bodies.** In order to examine differences in the contextual susceptibility of bodies versus faces, we computed the reduction in accuracy rates between congruent and incongruent combinations, for body categorization and face categorization, collapsed across emotions. Independent samples  $t$  test were performed with the congruency effect as the dependent variable. Congruency effects were strongly influenced by the target type (faces or bodies). Face expression accuracy was reduced by 39.8% ( $SD = 2.6\%$ ) by incongruent bodies, while body accuracy was reduced by 20.5% ( $SD = 2.6\%$ ) by incongruent faces,  $t(81) = 3.39$ ,  $p < .001$ , Cohen's  $d = 0.75$ , see Figure 4. Hence, faces were far more

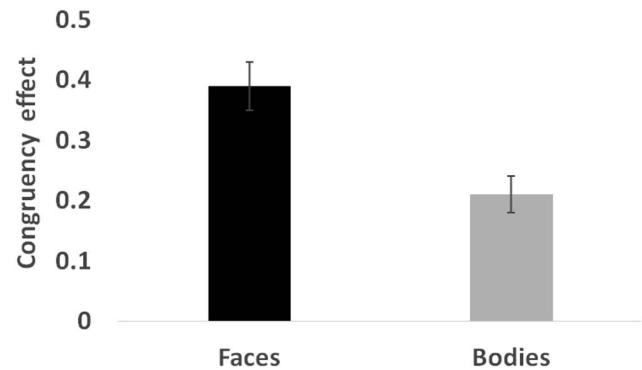


Figure 4. Mean congruency effects (and *SD*) for faces (in the face categorization task) and bodies (in the body categorization task). Congruency effects were calculated by subtracting the accuracy rates between congruent combinations and incongruent combinations, across all emotions.

susceptible than bodies to context effects. These findings are particularly striking given the fact that isolated faces were better recognized than isolated bodies (See Table 1).

As previously noted, isolated disgust bodies were poorly recognized in the baseline condition. This low recognition raises a concern that the contextual effects of faces on bodies may have been disproportionally driven by this atypical emotional category. In order to rule out this possibility we reanalyzed the data without the disgust bodies (and faces). The results of this analysis indicate that the bidirectional contextual effects hold strong for all other categories. Nearly all previous ANOVAs presented similar results and effect sizes for both "Categorize the face" and "Categorize the body" conditions. Specifically, similar congruency effects were present for each and every emotional combination (for angry and fear faces: all Cohen's  $d > .1$ , for happy faces Cohen's  $d = .71$ ; for all bodies: all Cohen's  $d > .57$ ).

Once again, we compared the relative susceptibility of faces and bodies to contextual effects. First, a comparison of the isolated stimuli found no difference between the recognition of isolated faces ( $M = .92$ ,  $SD = .09$ ) and isolated bodies ( $M = .91$ ,  $SD = .08$ ),  $F(1, 118) = 2.1$ ,  $p = .15$ ,  $\eta_p^2 = .02$ . Next, we replicated the finding that congruency effects were strongly influenced by the target type (faces or bodies). Faces accuracy was reduced by 40.0% ( $SD = 3.0\%$ ) by incongruent bodies, while body accuracy was reduced by 18.8% ( $SD = 2.7\%$ ) by incongruent faces,  $t(81) = 3.43$ ,  $p < .001$ , Cohen's  $d = 0.74$ , see Figure 5. Hence, even after excluding disgust from the analysis, congruency effects were prominently present, and faces were more susceptible than bodies to context effects.

To summarize, congruency effects, reflecting body-face integration, changed as a function of the task and the Emotion Target. Evidence for asymmetrical, bidirectional contextual influence was found. Both faces and bodies were influenced by each other's context; however, the susceptibility to contextual influence was far more pronounced for faces than for bodies. Importantly, these results replicated after removing the ambiguous disgust stimuli, and hence they cannot be attributed to stimulus clarity.

**The role of inherent target confusability in driving context effects.** One possible cause of context effects on emotion categorization is that the target includes an inherent ambiguity and is

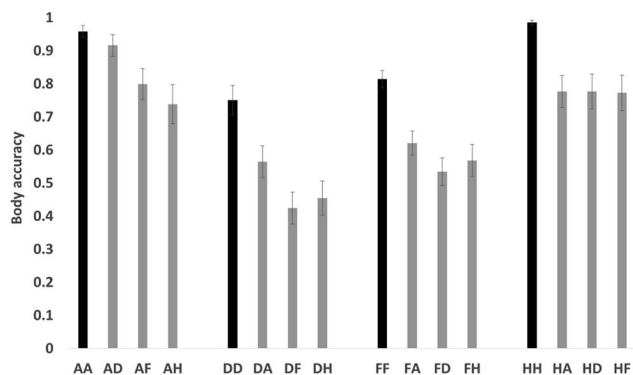


Figure 3. Mean accuracy (and *SE*) while categorizing body expressions with congruent face expressions (black bars) and incongruent face expressions (gray bars). A = Anger, D = Disgust, F = Fear, H = Happy. The first letter denotes the body emotion and the second letter denotes the face emotion (e.g., AD = anger body with disgusted face).

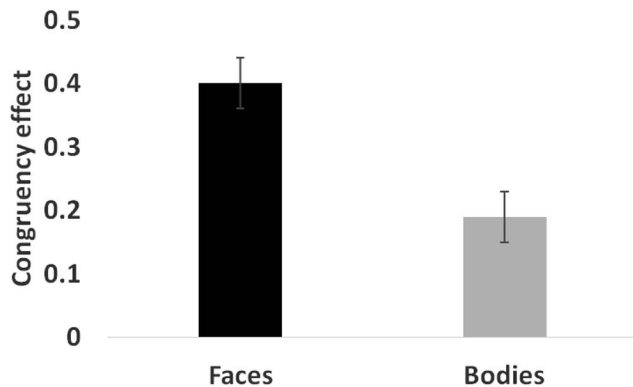


Figure 5. Mean congruency effects (and SD) for faces (in the face categorization task) and bodies (in the body categorization task) when disgust stimuli were removed from the analysis. Congruency effects were calculated by subtracting the accuracy rates between congruent combinations and incongruent combinations, across all emotions (without disgust).

naturally inclined to some errors more than others. For example, if a disgusted face (in isolation) displays a natural error confusability with anger but less so with fear, we may expect stronger context effects when the disgust face is combined with angry than with fearful bodies.

In order to examine whether such confusability played a role in determining the contextual categorization shifts, we calculated error rates for each stimulus, in each of the emotional categories presented in isolation. For example, in the case of isolated angry facial expressions, we computed the probability of labeling erroneously the particular angry face as the other emotions (Disgust, Fear, and Happiness, see Table 1 for all error means), thus establishing a baseline for confusability. Next, we computed each stimulus's bias score for the contextualized task. For example, for participants categorizing a contextualized angry face, we computed the tendency to respond according to the different incongruent body contexts. We then examined the correlation between the confusability in the isolated stimuli condition and between the responses in the contextualized task.

**The role of confusability in the face categorization task.** The confusability of isolated faces was significantly correlated with the pattern of the contextualized influence from bodies ( $r(70) = .65$ ,  $p < .001$ ), across all emotions. Thus, perceptual similarity explained contextual effects in emotional expressions.

**The role of confusability in the body categorization task.** The confusability of isolated bodies was significantly correlated with the pattern of the contextualized influence from faces ( $r(70) = .83$ ,  $p < .001$ ). Again, the pattern of confusability in isolation predicted the errors made with contextualized body stimuli.

**Does conceptual emotional similarity drive context effects?** As noted, context may change the categorization of emotional cues via perceptual similarity or via emotional similarity. If contextual effects operate because the emotions are conceptually similar, symmetrical patterns of contextual effects should be observed in the effects of faces on bodies and in the effects of bodies on faces. For example, if disgust faces are more influenced by anger bodies than by fear bodies, then disgust bodies should also be more influenced by anger faces than by fear faces. A comparison of the

patterns across Figures 2 and 3 clearly show that this is not the case as very different contextual patterns emerged for faces and bodies. A Pearson correlation across mean values of contextualized stimuli in the face and body confirmed that each expressive channel displayed different patterns of contextual influence  $r(14) = -0.06$ ,  $p = .8$ .

To summarize, perceptual, but not conceptual confusability seems to play a key role in the categorization pattern, as it predicted the tendency to respond as the incongruent context.

## Full Person Categorization

In this condition no instruction was given to focus on the face or body, but rather, to categorize the emotion of the person. Because responses corresponding to the face or body are equally valid, a standard accuracy analysis would not provide meaningful results. Nevertheless, the data allow us to assess the relative impact of incongruent faces on bodies, and of incongruent bodies on faces, as next described.

To assess the impact of incongruent bodies on faces, we compared categorizations of congruent combinations (e.g., an anger face on an anger body) with categorizations of combinations in which the same face appeared with incongruent bodies (e.g., anger face on fear body, anger face on disgust body, etc.). By examining the likelihood of categorizing the full stimuli as the face emotion (i.e., "anger") in congruent versus incongruent combinations we could assess the differential impact of specific incongruent bodies on the face.

Similarly, to assess the impact of incongruent faces on bodies, we compared categorizations of congruent combinations (e.g., an anger face on an anger body) with categorizations of combinations in which the same body appeared with incongruent faces (e.g., fear face on angry body, disgust face on angry body, etc.). By examining the likelihood of categorizing the full stimuli as the body emotion (i.e., anger) in congruent versus incongruent combinations we could assess the differential impact of specific incongruent faces on the body.

**Impact of incongruent bodies on face categorizations.** To test the impact of incongruent bodies on emotional face categorizations we ran a 4 (Face: anger, fear, disgust, happy)  $\times$  4 (Body: anger, fear, disgust, happy) repeated-measures ANOVA on the percent of categorizations of the compound stimuli that coincided with the face. A significant effect of the face indicated that some facial expressions were more susceptible to body context than others,  $F(3, 105) = 11.64$ ,  $p < .0001$ ,  $\eta_p^2 = .25$ , and a significant body effect indicated that some bodies served as more powerful contextualizers than others,  $F(3, 105) = 50.82$ ,  $p < .0001$ ,  $\eta_p^2 = .59$ . Importantly, a significant face  $\times$  body interaction emerged indicating that specific combinations between faces and bodies drove particularly potent context effects of the body on the face,  $F(9, 333) = 47.15$ ,  $p < .0001$ ,  $\eta_p^2 = .57$ . To better understand the interaction, we broke down our analysis and ran separate ANOVAs for each facial expression category.

**Anger faces in context.** An ANOVA testing the categorization of anger faces in different body contexts (anger, fear, disgust, happy) showed a strong influence of the body context,  $F(3, 105) = 90.4$ ,  $p < .0001$ ,  $\eta_p^2 = .72$ . Specifically, as seen in Figure 5, a categorization of anger was far more likely for congruent angry face-angry body combinations than for angry faces with disgust

bodies,  $t(35) = 10.8, p < .0001$  or angry face with fearful bodies  $t(35) = 3.9, p < .0001$ . Interestingly, compared to the congruent angry compounds, angry faces paired with happy bodies were more likely to be categorized as angry  $t(35) = 5.37, p < .0001$ .

**Disgust faces in context.** An ANOVA testing the categorization of disgust faces in different body contexts (disgust, anger, fear, happy) showed a strong influence of the body context,  $F(3, 105) = 36.19, p < .0001, \eta_p^2 = .51$ . As seen in Figure 5, a categorization of disgust was far more likely for congruent disgust combinations than for disgust faces with angry bodies,  $t(35) = 4.9, p < .0001$ . However, congruent disgust compounds were just as likely to be categorized as “disgust” as disgust faces with fearful bodies  $t(35) = .9, p = .33$ . Finally, following the pattern of anger faces, disgust faces with happy bodies were more likely to be categorized as disgust than disgust faces with congruent disgust bodies  $t(35) = 3.14, p < .003$ .

**Fear faces in context.** An ANOVA testing the categorization of fear faces in different body contexts (fear, anger, disgust, happy) showed a strong influence of the body context,  $F(3, 105) = 56.85, p < .0001, \eta_p^2 = .62$ . As seen in Figure 5, a categorization of fear was far more likely for congruent fear combinations than for fear faces with angry bodies,  $t(35) = 9.1, p < .0001$  or fear faces with disgust bodies,  $t(35) = 4.2, p < .0001$ . However, congruent fear combinations were just as likely to be categorized as “fearful” as were fear faces with happy bodies,  $t(37) = 1.1, p = .26$ .

**Happy faces in context.** An ANOVA testing the categorization of happy faces in different body contexts (happy, anger, disgust, fear) showed a strong influence of the body context,  $F(3, 105) = 23.01, p < .0001, \eta_p^2 = .40$ . As seen in Figure 5, a categorization of happy was far more likely for congruent happy combinations than for happy faces with angry bodies,  $t(35) = 6.1, p < .0001$ , happy faces with fear bodies,  $t(35) = 4.5, p < .0001$ , or happy with disgust bodies  $t(35) = 8.7, p < .0001$ .

To summarize, all face expression categories showed susceptibility to incongruent body combinations, albeit the magnitude and nature of the effect was dependent on the specific face–body combinations. Interestingly, the likelihood of classifying some incongruent compounds as the face emotion was increased when the incongruent body was happy. This intriguing effect may reflect two different processes. First, this may reflect the ambiguity of the body and the ease at which it can be perceptually assimilated with diverse faces. This may be the case with happy bodies that may seem angry due to both categories displaying high arousal and extended arms with clenched fists. Alternatively, incongruent bodies may boost recognition via contrast, by appearing clearly different from the face and clarifying its unique category.

**Impact of incongruent faces on body categorizations.** To test the impact of incongruent faces on emotional body categorizations we ran a 4 (Body: anger, fear, disgust, happy)  $\times$  4 (Face: anger, fear, disgust, happy) mixed ANOVA on the percent of categorizations of the compound stimuli that coincided with the body. A significant effect of the body indicated that some bodies were more susceptible to face influence than others,  $F(3, 105) = 13.29, p < .0001, \eta_p^2 = .29$ , and a significant effect of the face indicated that some facial expressions served as more powerful contextualizers than others,  $F(3, 105) = 25.41, p < .0001, \eta_p^2 = .42$ . Importantly, a significant face  $\times$  body interaction emerged indicating that specific combinations between faces and bodies drove particularly potent context effects of the face on the body,

$F(9, 315) = 231.1, p < .0001, \eta_p^2 = .87$ . To better understand the interaction, we broke down our analysis and ran separate ANOVAs for each body expression category.

**Anger bodies in context.** An ANOVA testing the categorization of anger bodies in different face contexts (anger, fear, disgust, happy) showed a strong influence of the face context,  $F(3, 105) = 137.9, p < .0001, \eta_p^2 = .79$ . Specifically, as seen in Figure 6, a categorization of anger was far more likely for congruent angry bodies with angry face combinations than for angry bodies with disgust faces,  $t(35) = 3.2, p < .002$ , with fearful faces  $t(35) = 9.3, p < .0001$ , or with happy faces,  $t(35) = 22.8, p < .0001$ .

**Disgust bodies in context.** An ANOVA testing the categorization of disgust bodies in different face contexts (disgust, anger, fear, happy) showed a strong influence of the face context,  $F(3, 105) = 117.4, p < .0001, \eta_p^2 = .78$ . As seen in Figure 6, a categorization of disgust was far more likely for congruent disgust combinations than for disgust bodies with anger faces,  $t(35) = 7.8, p < .0001$ , fear faces,  $t(35) = 11.5, p < .0001$ , or happy faces,  $t(35) = 14.7, p < .0001$ .

**Fear bodies in context.** An ANOVA testing the categorization of fear bodies in different face contexts (fear, anger, disgust, happy) showed a strong influence of the body context,  $F(3, 105) = 165.1, p < .0001, \eta_p^2 = .82$ . As seen in Figure 6, a categorization of fear was far more likely for congruent fear combinations than for fear bodies with anger faces,  $t(35) = 10.6, p < .0001$ , disgust faces,  $t(35) = 12.5, p < .0001$ , or happy faces,  $t(35) = 30.6, p < .0001$ .

**Happy bodies in context.** An ANOVA testing the categorization of happy bodies in different face contexts (happy, anger, disgust, fear) showed a strong influence of the face context,  $F(3, 105) = 735, p < .0001, \eta_p^2 = .95$ . As seen in Figure 6, a categorization of happy was far more likely for congruent happy combinations than for happy bodies with anger faces,  $t(35) = 40.5, p < .0001$ , happy bodies with fear faces,  $t(35) = 31.4, p < .0001$ , or happy bodies with disgust faces  $t(35) = 105.6, p < .0001$ .

To summarize, all body expression categories showed susceptibility to incongruent face combinations, albeit the magnitude of

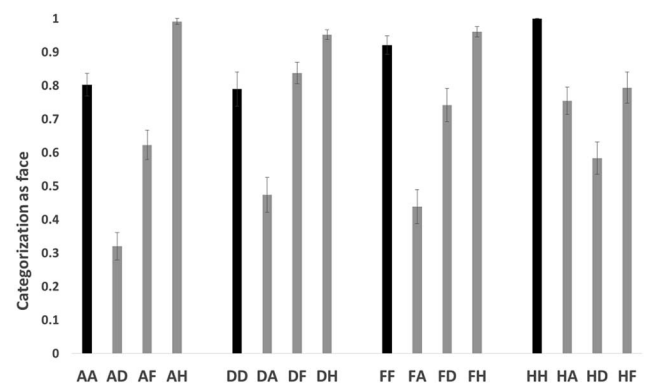


Figure 6. Likelihood of categorizing the full face–body stimuli as the face emotion in congruent (black bars) versus incongruent combinations (gray bars). Mean accuracy (and SE) are presented. A = Anger, D = Disgust, F = Fear, H = Happy. The first letter denotes the face emotion and the second letter denotes the body emotion (e.g., AD = anger face with disgusted body). Note that in this condition participants were not requested to categorize the face or the body, but rather to categorize the emotion of the person they were viewing.



the effect was dependent on the specific face–body combinations. Interestingly, a comparison of Figures 6 and 7 suggests that although bodies influenced faces and vice versa, the impact that faces had on bodies was overall larger and more consistent (see also Figure S3 in the online supplemental material). As previously demonstrated, repeating the analysis without disgust bodies and faces yielded the same results pattern: a body–face integration existed (in the form of congruency effects) for all conditions.

## Discussion

Although much research has recently focused on the impact of body context on facial expressions, the face itself may also serve as context for its surroundings. Thus, body language may impact facial expressions, but facial expressions may also impact body language, which once contextualized may further impact facial expressions. As such, we view contextual effects as bidirectional and circular, from faces to bodies and vice versa. The present study broadens our understanding of the perceptual interactions between emotional faces and bodies. We had three goals: first, to identify context effects for bodies and directly compare them with context effects for faces. Second, to examine the role of perceptual similarity in the shift patterns of contextualized emotional stimuli. And third, to inspect perceptual interactions between the body and face under free viewing versus instructions to focus on the face or body.

As predicted, context effects were bidirectional and were found for both contextualized bodies and contextualized faces (when defined as targets). Although isolated faces were on average better recognized than isolated bodies, faces were more susceptible to body influence than vice versa. In addition, confusability seemed to play a key role in explaining the contextual shift. Finally, in a naturalistic condition in which no specific instructions were given to focus on either cue, we found that both faces and bodies influenced recognition. While face-based categorizations predominated, certain face–body combinations presented equal distribution, and on one combination even exerted body precedence (spe-

cifically, in angry-body–disgust-face combinations). Importantly, an interaction between the given instruction and the unique body–face combinations appeared, suggesting that body–face integration is prone to contextual influence itself and changes as a function of circumstantial characteristics.

The bidirectional context effects, for both contextualized bodies and contextualized faces, clearly showed that the body can serve as a target, too. However, although isolated bodies were less recognized than isolated faces, faces were more susceptible to body influence than vice versa. That is, we found evidence for asymmetrical context effects. Given that faces are more distinctive than bodies when presented alone, why would they be more susceptible to context effects?

One possibility is that, at least in Western culture, humans have a strong tendency to focus on and interpret faces (e.g., Bjornsdottir, Tskhay, Ishii, & Rule, 2017). In their everyday life, humans specialize in face perception and may be accustomed to interpreting faces based on the context in which they are perceived (Kret et al., 2013). This may explain why the impact of the face on the body is weaker. Humans are not accustomed to perceiving bodies alone, and they consistently underestimate the importance of the body, even when it is more diagnostic than the face (Aviezer et al., 2012a; Rice, Phillips, Natu, An, & O'Toole, 2013). Therefore, the influence of the face on the body may not come naturally as emotional bodies are seldom in our focus of attention. Thus, when people are asked to categorize the body they may be less prone to integrate, or to pay attention to other surrounding cues (e.g., Lavie, 2010).

Our study replicates and extends the work of Kret and colleagues (2013) who examined bidirectional face–body context effects in several important ways. First, like Kret and colleagues, we demonstrate clear bidirectional context effects from the body to the face and from the face to the body. Unlike Kret and colleagues, in which the stimuli recognition displayed a ceiling effect, our study was also capable of demonstrating that these effects are asymmetrical: faces were more susceptible to context effects than bodies. Furthermore, the pattern of categorization shifts was quite different in terms of specific affected combinations. In general, our data reflected stronger congruency effects, especially for angry faces and happy bodies. One likely explanation for this discrepancy is that Kret et al.'s study only used three emotional categories, while we used four. Thus, the mere addition of another emotional category likely altered the patterns of confusability in our design. Specifically, adding disgust faces and bodies may have dramatically influenced accuracy rates, as they have more ambiguous displays and are inherently confusable with other negative emotions (e.g., Aviezer, Hassin, Ryan et al., 2008; Jack, Sun, Delis, Garrod, & Schyns, 2016; Widen & Russell, 2010; Russell, 1980; Yoder, Widen, & Russell, 2016). However, as demonstrated, even when disgust stimuli were removed from analysis, the bidirectional effects held strong.

Our study also added a more naturalistic condition allowing us to test the perception of emotion from the person without prioritizing the face or body. Although that design did not allow us to test interference from a task-irrelevant cue, our results suggest that both faces and bodies, influence each other during emotion perception. As noted, face-based categorizations predominated, but under the naturalistic condition combinations of anger and disgust

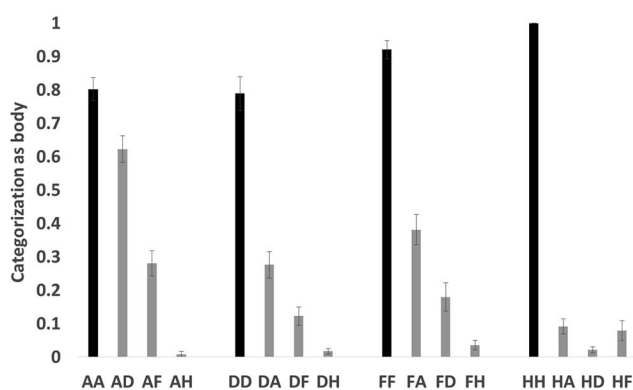


Figure 7. Likelihood of categorizing the full face–body stimuli as the body emotion in congruent (black bars) versus incongruent combinations (gray bars). Mean accuracy (and SE) are presented. A = Anger, D = Disgust, F = Fear, H = Happy. The first letter denotes the body emotion and the second letter denotes the face emotion (e.g., AD = anger body with disgusted face). Note that in this condition participants were not requested to categorize the face or the body, but rather, to categorize the emotion of the person they were viewing.



were determined by the expressing body, replicating prior work (Aviezer, Hassin, Ryan et al., 2008).

Moreover, we found an interaction between the given instruction and the unique body–face combinations. For example, when we examined the fear–anger combinations (especially angry body with a fearful face), the exact response pattern was dependent on the specific instruction. A clear paradoxical rebound effect was found: when participants were asked to categorize the face, fear faces on anger bodies were categorized equally as fearful and angry. However, in the “full person” condition the majority of participants categorized fear faces as fearful and the context bias was reduced. The same rebound effect pattern emerged in happy face combinations: Again, in the “full person” condition the face took precedence. However, when participants’ attention turned to the face (i.e., in the “categorize the face” condition), faces were more susceptible to contextual influence. These findings are intriguing given previous studies demonstrating that when instructed to focus on the face, context effects are automatic (Aviezer et al., 2011) and they demonstrate that context effects may be more fragile and prone to the contextual demands of the task.

It should be noted that the stimuli used in the current study involved pure body language without the enhancement of emotional paraphernalia and scene context as used in previous work (Aviezer et al., 2011; Aviezer, Hassin, Ryan et al., 2008; Aviezer et al., 2012b). Using enhanced unequivocal body context may prevent the body from being reinterpreted by the face and promote perceptual change to the face. By contrast, the bodies used in the current study conveyed emotion via body language alone which is more ambiguous, and thus may itself be contextually reinterpreted by strong face signals to fit the emotion of the face. As real-life faces are typically encountered while embedded in an extremely rich context, they may be especially prone to contextual influence.

Our results also highlight an interesting distinction between the signal value of stereotypical faces and bodies. In faces, the major confusability occurs between negative expressions (e.g., between anger and disgust; Susskind et al., 2007), whereas stereotypical happy faces are extremely well recognized and clearly distinct from negative face expressions. Bodies, however, may display a very different pattern of confusability. Previous studies which explored the categorization of isolated emotional bodies found that happiness was poorly recognized, and often miscategorized as anger (Atkinson, Dittrich, Gemmell, & Young, 2004; De Gelder & Van den Stock, 2011; Fridin, Barliya, Schechtman, de Gelder, & Flash, 2009; Kret et al., 2013). Moreover, previous results indicate that angry body expressions were categorized significantly more often as “Happy” than as “Sad”, and fear target expressions were categorized significantly more often as “Angry” and “Happy” than as “Sad” (De Gelder & Van den Stock, 2011). Thus, cross-valence miscategorizations prevail in the case of bodies, but not faces.

In the current study, confusability emerged as an important player in contextual shifts. For example, if the tendency to confuse an angry facial expression with a disgusted one is high, we can predict an increased tendency to miscategorize the angry facial expression as a disgusted one, when planted in a disgusted body context. Although evidence for this pattern was found in both faces and bodies, it was more consistent and robust in the former. We consider two different accounts in explaining the confusability patterns in body face combinations: the concept of *emotional seeds*

as suggested by Aviezer et al. (2011) and confusability based on valence and arousal.

The metaphor of emotional seeds was used to describe the influence of similarity between expressions, in order to predict the pattern of contextual shift in body–face integrations. The concept of *seeds* suggests that there is overlapping perceptual information shared by different facial expressions. These seeds lie dormant when the face is presented alone, but once placed in fitting context, the seed may be activated. When the context matches the seed hidden in the target facial expression, these seeds are amplified and may override the original facial expression. However, when the match between the context (powerful as it may be) and the seeds is weak, it will have a low impact (Aviezer et al., 2011). Following this model, the seeds we found in the error analysis were supposed to prosper once placed in a matched context. While this concept of seeds predicts to some extent the context bias results, as reflected in the confusability prediction, it does not explain the full pattern.

Alternatively, we can consider the role of valence and arousal in determining the confusability pattern. According to this account, a shared affective dimension (either valence or arousal) may be central in determining confusions between emotions. Following Russell’s Circumplex theory of affect (Russell, 1980), joy and anger are categorized with a similar level of arousal, while sadness is categorized on a lower level. The same pattern appears in the work of Dael, Goudbeek, and Scherer (2013), which also placed arousal as a strong determinant of the perception of emotional hand gestures, as opposed to valence. If the body indeed conveys primarily the arousal level, it follows that it will be easier to confuse anger, fear and happiness (which share similar levels of arousal). Again, this approach may explain some of the variance but the full picture remains more complex. Furthermore, the fact that participants overall recognized the specific emotions of the isolated stimuli speaks against a broad dimensional confusability.

Mondloch et al. (2013) found that congruency effects when categorizing faces were not symmetrical in their direction of influence. This asymmetrical principle is replicated in our data too, as we found not only an asymmetry in context effects (between specific emotional combinations), but also between contextual bodies and contextual faces. As in Mondloch et al. (2013), our results do not unequivocally support either one of the models (seeds or dimensional), as there isn’t a clear path of categorization shift. In other words, as in Mondloch et al. (2013), our results are not fully consistent with predictions made by the emotional seeds model or by the dimensional model. It is clear however, that the different patterns between contextual effects in faces and bodies speak against a conceptual emotional confusability. Had that been the case, the same targets in context would be confused in both faces and bodies (e.g., if disgust faces are strongly impacted by anger, but not fear-body context, then disgust bodies should be strongly impacted by anger faces but not fear facial context).

More mundane alternative explanations to contextual effects may also be considered and ruled out. First, it is possible that the general congruency effect we find does not reflect body–face integration but rather, demand characteristics or a general attentional effect. This explanation seems less plausible because it does not predict some body–face combination creating stronger context effects than others. Second, in the “whole body” condition, one can argue that it can be easily explained purely by visual scanning pattern (the face scanning is prioritized over the body stimuli). Yet

again, we find no evidence for a consistent pattern of the face taking over, but rather a dependency in the specific condition combination. Finally, our stimuli in the current study were static and not dynamic. Dynamic emotional information is considered to be richer, more ecological, and is known to increase accuracy rates (Krumhuber, Kappas, & Manstead, 2013), which in theory may reduce contextual effects. However, recent work with dynamic stimuli examining how bodies impact facial expression recognition found similar results to those revealed in the current study (Nelson & Mondloch, 2017).

To conclude, the current study supports a body of research showing that emotional expressions are not diagnostic readouts of specific emotional experiences. Rather, they are complex cues whose meaning can and does shift as a function of context. Bidirectional influence occurred in the current study, such that the body expression can influence prototypical facial expressions categorization, and facial expressions themselves can serve as a context and influence the interpretation of emotional body language. Interestingly, the pattern of contextual biases is not symmetrical between emotions and is strongly dependent on other characteristics such as body–face combination and the task demands themselves. This phenomenon fits the view that emotional perception is a flexible process in which the interpretation of facial and body cues changes as a function of the context and the ongoing changing conditions.

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