Orientation Affects Sensitivity to Complex Emotions in Eye Regions

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Abstract

Inferring humans' complex emotions is challenging but can be done with surprisingly limited emotion signals, including merely the eyes alone. Here, we test for a role of lower-level perceptual processes involved in such sensitivity using the well-validated "Reading the Mind in the Eyes" task. Over three experiments, we manipulate configural processing to show that it contributes to sensitivity to complex emotion from human eye regions. Specifically, inversion, a well-established manipulation affecting configural processing, undermined sensitivity to complex emotions in eye regions (Experiments 1-3). Manipulating orientation extended to undermine sensitivity to non-mentalistic information from human eye regions (gender; Experiment 2) but did not extend to affect sensitivity to attributes of non-human animals (Experiment 3). Taken together, the current findings provide evidence for the novel hypothesis that configural processing facilitates sensitivity to complex emotions conveyed by the eyes.

Keywords: face perception, eyes, complex emotions, sensitivity, configural processing

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Reflecting a belief that eyes are “windows to the soul,” eyes are central to inferring inner states (Adams & Kleck, 2003, 2005) and navigating social interactions (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001; Frischen, Bayliss, & Tipper, 2007). Although visual information enables understanding others (Baron-Cohen, 1994), most work examining mechanisms for this sensitivity have focused on top-down factors affecting it (e.g., culture; Adams et al., 2009) or low-level differences between basic (but not complex) emotions (e.g., Smith, Cottrell, Gosselin, & Schyns, 2005). Similarly, the interpersonal sensitivity literature focuses on how aspects of perceivers (e.g., Hall, Andrzejewski, & Yopchick, 2009) or targets (e.g., Gutsell & Inzlicht, 2010) affect inferring affective states from nonverbal cues. Here, we examined whether *configural processing* – a perceptual process characteristic of face processing – affects sensitivity to complex emotions from eye regions. Configural processing has been implicated in basic emotion perception (e.g., Krumhuber, Lai, Rosin, & Hugenberg, 2019), but whether it contributes to complex emotion decoding from eye regions is understudied. We focus on the eyes because they appear central in reading minds from faces and because common measures of complex emotion decoding focus on eye regions (Baron-Cohen, 1994).

Although configural processing has had multiple definitions (for a review, see Maurer, Le Grand, & Mondloch, 2002), it is often used to describe the ability to integrate features into a perceptual Gestalt (A. Young, Hellawell, & Hay, 2013). We used the Face Inversion Effect (Yin, 1969) to test if configural processing affects complex emotion decoding from the eyes. Inversion is the “gold standard” manipulation of configural processing (e.g., A. Young et al., 2013), maintaining features but disrupting their typical configuration, thereby undermining face-typical processing. Whereas inversion is often used with full faces, it also elicits inefficient processing for featural regions. Inverting eye regions, for example, undermines the ability to perceive and remember them (Civile, McLaren, & McLaren, 2014; Rakover & Teucher, 1997) and impairs gaze sensitivity (Jenkins & Langton, 2003; Senju & Hasegawa, 2006; Vecera & Johnson, 1995). These findings show inversion to undermine interpreting cues from eye regions.

Prior work suggests perceptual processes affect complex emotion decoding from the eyes. Seeing eyes, for example, enables primary emotion decoding (Ganel, Goshen-Gotstein, & Goodale, 2005) and thinking about complex emotions (Calder et al., 2002). It also facilitates mind attributions characteristic of having a complex inner life (Khalid, Deska, & Hugenberg, 2016; Looser & Wheatley, 2010; Schein & Gray, 2015). Decoding complex emotions from eyes also elicits brain activation suggesting that face processing is engaged during decoding (Adams et al., 2009). We hypothesized that configural processing contributes to this sensitivity. Indeed, extracting socially relevant cues from faces is theorized to rely, in part, on configural processing (Wilson, Young, Rule, & Hugenberg, 2018).

Prior work also suggests configural processing to specifically affect complex emotion decoding. Inversion impairs basic emotion identification (e.g., Calder, Young, Keane, & Dean, 2000; McKelvie, 1995; White, 1999; S. Young & Hugenberg, 2010). Indeed, people better identify positive and negative emotions on upright versus inverted faces (Bombari et al., 2013). These ingroup identification advantages for basic emotions emerge in part because these faces are more likely to be configurally processed (S. Young & Hugenberg, 2010). Because ingroup advantages have been shown for complex emotions (Adams et al., 2009), configural processing may play a role in decoding too. Finally, configural processing affects *humanization* (Hugenberg et al., 2016), relevant here because perceiving humanness involves ascribing complex emotions (e.g., Leyens et al., 2000). Indeed, inversion undermines the tendency for expressive faces to appear to have sophisticated minds (Krumhuber et al., 2019). Configural processing also seems important to make inferences about humanlike traits (Wilson et al., 2018) and faculties (Hugenberg et al., 2016). Given these links between configural processing and humanness, it seemed likely that disrupting configural processing would undermine sensitivity to the complex emotions characterizing humanity.

We tested whether configural processing affects decoding complex emotions from eyes using the Reading the Mind in the Eyes task (RME; Baron-Cohen et al., 2001) to quantify decoding. Recommended by the NIMH to assess emotional perspective taking, the RME measures sensitivity to complex emotions (e.g., Vellante et al., 2013). Each trial features an eye region displaying a specific complex emotion and four attributes. Participants select the attribute reflecting what each person is feeling. Sensitivity requires cognitive (e.g., understanding emotions) and perceptual (e.g., using visual cues) operations. Although several cognitive contributions to this sensitivity have been identified (e.g., group identity; Stevenson, Soto, & Adams, 2012), the current work, to our knowledge, is of the first to manipulate *perceptual* processes to identify potential contributions.

We had two goals. The first was to show that manipulating configural processing (via inversion) affects complex emotion encoding from eyes (Experiments 1-3). The second was to test whether this effect was specific to complex emotion sensitivity or if inversion broadly undermined sensitivity to visual cues. In Experiment 2, we examined orientation effects on complex emotion and gender sensitivity in the same eye regions. Because configural processing is largely specific to human stimuli (Maurer et al., 2002) and human-relevant traits (Wilson et al., 2018), we tested if inversion undermined sensitivity to inferences about human eye regions, but not non-human animals, in Experiment 3.

Experiment 1

Experiment 1 tested whether orientation affects complex emotion decoding from eye regions. Participants completed the RME (Baron-Cohen et al., 2001) modified to include upright and inverted eye regions within-participants. We hypothesized better decoding from upright versus inverted eye regions.

Method

Participants

We recruited 40 participants (M_{age} = 37.85 years, *SD* = 10.80; $M_{years\ of\ education}$ = 14.73, *SD* = 1.88; 19 female). This sample provided 91.1% power to detect an effect size of *d* = 0.65 (between a medium and large effect) for an orientation effect based on a power analysis specifying a crossed design and setting participants and items as random factors (www.jakewestfall.org/pangea). All studies were IRB approved. A sensitivity analysis for the described orientation effect indicated that the minimum detectable effect size was log-odds ratio = -0.22 with power = 0.80 and alpha = 0.05.

Materials and Procedure

Participants completed a self-paced RME (Baron-Cohen et al., 2001) consisting of 36 randomly presented grayscale images of eye regions. On each trial (Figure 1a), participants viewed an eye region and four attributes (one target and three foils) beneath it with comparable emotional qualities (for details, see Baron-Cohen et al., 2001). Participants selected the attribute best describing the depicted emotion. Orientation was counterbalanced such that eye regions were equally likely seen upright or inverted.

Although most RME work examines decoding across items, some work acknowledges emotion valence (e.g., Franklin Jr. & Zebrowitz, 2016). We had no hypotheses regarding valence because orientation affects sensitivity to several basic emotions (e.g., Bombari et al., 2013). However, we balanced valence across orientation using norms categorizing items as positive, neutral, or negative (Harkness, Sabbagh, Jacobson, Chowdrey, & Chen, 2005). There were four positive, eight neutral, and six negative items in each orientation. Participants also indicated their instruction adherence ("Did you follow the instructions to the best of your ability?" rated from 1 *[not at all]* to 7 *[completely]; M* = 6.90, *SD* = 0.30).

Results

We examined orientation effects in mixed effects models logistically regressing Decoding (decoded = 1, not decoded = 0) on Orientation (upright = -1, inverted = 1). The random effects structure specified intercepts varying by participant and item and orientation effects varying by participant and item. This structure ruled against specific participants or items driving the results. An exploratory model specified fixed effects of Emotion Valence treated as a factor with three levels (negative, neutral, and positive) and the interaction term. Across experiments, models were built using the lme4 package (Bates, Maechler, Bolker, & Walker, 2015) in R. 95% CIs were estimated using the *confint* function and refer to the sizes of effects. Model *p*-values were calculated using the lmerTest package (Kuznetsova, Brockhoff, & Christensen, 2017). Estimated marginal means were obtained using the emmeans package (Lenth, 2018). Sensitivity analyses conducted using the simr package (Green & MacLeod, 2016) determined the minimum effect size for the primary effect of interest in each experiment that maintained power at 0.80 as assessed by a model simulation with 1000 iterations per model (all data and code: https://osf.io/xmz2j/).

The random effects structure showed variability across intercepts for participants (*SD* = 0.85, 95% CI [0.59, 1.08]) and items (*SD* = 0.55, 95% CI [0.31, 0.71]). Orientation effects varied across participants (*SD* = 0.28, 95% CI [0.06, 0.43]) and items (*SD* = 0.15, 95% CI [0.01, 0.29]). A fixed Orientation effect showed better complex emotion decoding from upright (*Model estimate* = 0.70, *SE* = 0.05, 95% CI [0.60, 0.78]) versus inverted (*Model estimate* = 0.57, *SE* = 0.04, 95% CI [0.49, 0.64]) eye regions, $b = -0.29$, $SE = 0.08$, $z = 3.61$, $p = 0.003$, 95% CI [-0.46, -0.15].

The exploratory model including fixed effects of Emotion Valence and the interaction term did not improve fit over the first model, $\chi^2(4) = 3.47$, $p = 0.48$ (see Supplemental Material for details). Because Emotion Valence did not qualify an Orientation effect, it was not further examined.

Discussion

As expected, complex emotions were better decoded from upright versus inverted eye regions. This finding parallels findings showing that configurally processing eye regions elicits better understanding of eye gaze (Jenkins & Langton, 2003; Senju & Hasegawa, 2006). It also forges a link between work showing the role of configural processing in humanization (Hugenberg et al., 2016) and between humanization and complex emotions (Leyens et al., 2000). We show configural processing effects also emerge in sensitivity to complex emotions. Notably, the lower bounds of confidence intervals for the likelihood of decoding complex emotions were above chance (upright: 0.60; inverted: 0.49). Undermining configural processing thus does not sever sensitivity. Rather, perceptual operations are more likely among several contributors to complex emotion decoding from the eyes (e.g., group identity; Stevenson et al., 2012).

Experiment 2

In Experiment 2, we sought to determine if the orientation effect from Experiment 1 was specific to sensitivity to complex emotions or if it reflected broader sensitivity to cues from eye regions. We modified Experiment 1 so that participants decoded gender and complex emotions from upright and inverted eye regions. Judgment and orientation were manipulated within-participants. Gender trials are often used as controls in the RME (e.g., Adams et al., 2009; Harkness et al., 2005). Although they are matched in visual input, gender judgments, unlike complex emotion judgments, require non-mentalistic engagement with eye regions.

One possibility is that inversion undermines sensitivity to complex emotions, but not gender, in eye regions. Supporting this possibility, inversion sometimes prohibits the extraction of identity, but not gender, information, from faces (Cloutier, Mason, & Macrae, 2005). This pattern would reflect a specific configural processing effect on sensitivity to mentalistic cues. Alternatively, inversion may broadly undermine sensitivity to cues from eye regions. Indeed, inversion undermines myriad judgments of full faces including social categorization (Hugenberg et al., 2016). Inversion also prohibits the extraction of gender information from faces without rich information cuing gender (e.g., hairstyle; Cloutier & Macrae, 2007). Indeed, hairstyle appears to trigger category information (Macrae & Martin, 2007). Because eye regions lack such cues, inversion may undermine sensitivity in both judgments.

Method

Participants

We targeted 60 participants, providing 81.5% power to detect an effect size of d = 0.50 (a medium effect) for an interaction between Orientation and Judgment according to a power analysis specifying a crossed design and setting participants and items as random factors. Because preliminary analyses suggested this sample was potentially underpowered to detect an interaction, we recruited 30 additional participants. To account for this second wave, we set a more conservative alpha (0.01). One participant was excluded for entering an incorrect survey code. The analyzed sample included 89 MTurk participants (M_{age} = 35.90 years, *SD* = 13.99; $M_{years\ of\ education}$ = 14.81, *SD* = 2.42; 36 female). Participants adhered to task instructions (*M* = 6.85, *SD* = 0.39). A sensitivity analysis for the described orientation effect indicated a minimum detectable effect size of log-odds ratio = -0.20 with power = 0.80 and alpha = 0.05.

Modified RME

Because the RME comprises 18 male and 18 female eye regions., we modified it to comprise 18 emotion and 18 gender trials. Each trial comprised an eye region at the center of the screen and two attributes beneath it. On emotion trials, participants selected which of two attributes best reflected what the person was feeling. One attribute was the target used in Experiment 1. The other was the most selected foil in Experiment 1. On average, 19.44% (*SD* = 7.25%) of Experiment 1 participants chose foil used in Experiment 2. In gender trials, the words were “male” and “female.”

Four versions counterbalanced the eye regions shown in each judgment type (emotion and gender) and orientation (upright and inverted). Within the 18 trials of each judgment, nine eye regions were upright and nine inverted. In each version, participants made nine emotion judgments about female faces, nine emotion judgments about male faces, nine gender judgments about female faces, and nine gender judgments about male faces. Because there were nine trials in each of the four conditions counterbalancing judgment type and orientation, eye region gender could not be evenly split within orientation. Eye region gender was counterbalanced across versions. For example, whereas some participants would see more upright male eye regions in the emotion condition, others would see more upright female eye regions in the emotion condition.

Results

We examined orientation and judgment effects in a mixed effects model logistically regressing Decoding (not decoded = 0, decoded = 1) on Orientation (upright = -1, inverted = 1), Judgment (category = -1, emotion = 1), and their interaction. We modified the random effects structure from Experiment 1 to specify random slopes of Judgment by participant and item. The random effects structure showed variability across intercepts for participants (SD = 0.56, 95% CI [0.37, 0.76]) and items (SD = 0.91, 95% CI [0.60, 1.23]). Orientation effects varied across participants (SD = 0.09, 95% CI [0.01, 0.30]) and items (SD = 0.19, 95% CI [0.07, 0.34]). Judgment effects varied across participants (SD = 0.15, 95% CI [0.01, 0.43]) and items (SD = 0.66, 95% CI [0.39, 0.92]).

A fixed Orientation effect showed better complex emotion decoding from upright (*Model estimate* = 0.94, SE = 0.01, 95% CI [0.90, 0.96]) versus inverted (*Model estimate* = 0.89, SE = 0.02, 95% CI [0.85, 0.93]) eye regions, b = -.27, SE = 0.09, z = 3.05, p = 0.002, 95% CI [-0.48, -0.10]. A fixed Judgment effect showed better gender (*Model estimate* = 0.98, SE = 0.01, 95% CI [0.96, 0.99]) versus complex emotion (*Model estimate* = 0.75, SE = 0.03, 95% CI [0.69, 0.80]) decoding, b = -1.32, SE = 0.16, z = 8.18, p < 0.001, 95% CI [-1.72, -1.04]. No interaction emerged, b = -0.02, SE = 0.08, z = 0.30, p = 0.77, 95% CI [-0.15, 0.15] (Figure 2a).

Discussion

Complex emotion decoding was again better for upright versus inverted eye regions. Extending this effect to gender sensitivity, judgment did not qualify an orientation effect. Orientation effects across judgments reflect findings that inversion undermines gender sensitivity when cues highly indicative of gender are not available (Cloutier & Macrae, 2007; also see Macrae & Martin, 2007). Orientation effects emerged despite high performance in all conditions and even near ceiling gender sensitivity. Configural processing may thus more generally affect sensitivity to cues in eye regions even when cues are non-mentalistic. Indeed, brain activation reflecting configural processing and face perception emerges when extracting gender from faces (Cloutier, Turk, & Macrae, 2008) and when considering others' emotions (Kesler et al., 2001).

Because judgment did not qualify the orientation effect, an open question was whether inversion simply undermines sensitivity overall. To address this possibility, we examined orientation effects using different control trials in Experiment 3.

Experiment 3

In Experiment 3, we tested the generalizability of the orientation effects shown in Experiments 1 and 2 by including animal attribute control trials. Animal trials have been used as control trials in related complex emotion research (e.g., Harkness, Jacobson, Sinclair, Chan, & Sabbagh, 2012; Harkness et al., 2005). These trials comprise an animal image and four attributes. People select the attribute best describing the animal, mirroring RME trials but focusing on non-human stimuli. These trials are more conceptually similar to complex emotion decoding than gender decoding (Harkness et al., 2005) because both involve inferences about states while mirroring surface characteristics.

Animal trials are also a valuable control because, for most people, inversion has little effect on perceiving animals (Dahl, Rasch, & Chen, 2014; Hugenberg et al., 2016; but see S. Young, Goldberg, Rydell, & Hugenberg, 2019; S. Young, Tracy, Wilson, Rydell, & Hugenberg, 2019). Further, people appear to engage in configural processing more when evaluations are human-relevant (Wilson et al., 2018). Because matching non-human animals to attributes is not human-relevant, an upright configuration should not facilitate performance. We hypothesized a stronger orientation effect for complex emotion than animal attribute decoding.

Method

Participants

Like Experiment 2, we recruited 90 participants. Excluding one participant for entering an incorrect survey code, the analyzed sample comprised 89 MTurk participants (M_{age} = 35.37 years, *SD* = 10.94; $M_{years\ of\ education}$ = 15.18, *SD* = 2.29; 36 female). Participants adhered to task instructions (*M* = 6.70, *SD* = .70). A sensitivity analysis for the below-described interaction effect indicated that the minimum detectable effect size with power = 0.80 and alpha = 0.05 was a log-odds ratio = -0.11.

Modified RME

We modified the RME to include the 36 human eyes trials (i.e., eyes trials) and 36 animal trials. On animal trials, participants saw a black-and-white animal at the center of the screen and four attributes beneath it (e.g., Figure 1b). Participants selected the attribute best describing the animal. Four versions counterbalanced the orientation of eye regions and animals within-participants.

Twelve animal trials were used in past work (Harkness et al., 2005). The other 24 were created to match the number of RME stimuli. Targets and foils for new trials were selected by the experimenters and validated by 21 undergraduates (M_{age} = 19.81 years, *SD* = 3.23; 19 female). These participants selected the attribute that best described each animal (see Supplemental Material for new trial details). 73.15% (*SD* = 12.32%) of participants selected the target, suggesting performance was not at ceiling. There was no difference in the percentage of participants selecting the target in old (*M* = 0.78, *SD* = 0.12) and new trials (*M* = 0.71, *SD* = 0.12), trials, $t(34) = 1.63$, $p = 0.11$. Old and new trials were evenly distributed among upright and inverted animal trials. There was no difference in the percentage of participants selecting the target on trials designated as upright (or, depending on version, inverted; $M = 0.71$, $SD = 0.11$) versus inverted (or, depending on version, upright; $M = 0.75$, $SD = 0.13$), $t(34) = 0.37$, $p = 0.41$.

Results

We examined Orientation and Stimulus effects in a mixed effects model logistically regressing Decoding (not decoded = 0, decoded = 1) on Orientation (upright = -1, inverted = 1), Stimulus (animal = -1, human eyes = 1), and their interaction. We modified the random effects structure from Experiment 1 to specify a random slope of Stimulus by participant. The random effects structure showed variability across intercepts for participants ($SD = 1.03$, 95% CI [0.84, 1.20]) and items ($SD = 0.62$, 95% CI [0.48, 0.72]). Orientation effects varied across participants ($SD = 0.18$, 95% CI [0.06, 0.26]) and items ($SD = 0.21$, 95% CI [0.06, 0.27]). A Stimulus effect varied across participants ($SD = 0.39$, 95% CI [0.27, 0.47]).

Fixed Orientation, $b = -0.14$, $SE = 0.04$, $z = 3.19$, $p = 0.001$, 95% CI [-0.24, -0.06]. and Stimulus, $b = -0.44$, $SE = 0.04$, $z = 4.89$, $p < 0.001$, 95% CI [-0.61, -0.26], effects emerged. The expected Orientation × Stimulus interaction emerged (Figure 2b), $b = -0.15$, $SE = 0.04$, $z = 3.82$, $p < 0.001$, 95% CI [-0.23, -0.08]. Simple effects showed better decoding from upright (*Model estimate* = 0.69, $SE = 0.04$, 95% CI [0.61, 0.75]) versus inverted (*Model estimate* = 0.55, $SE = 0.04$, 95% CI [0.48, 0.62]) human eyes, $OR = 1.80$, $SE = 0.20$, $z = 5.28$, $p < 0.001$, 95% CI [1.45 2.24]. Attributes were similarly decoded from upright (*Model estimate* = 0.80, $SE = 0.03$, 95% CI [0.72, 0.85]) and inverted (*Model estimate* = 0.80, $SE = 0.03$, 95% CI [0.73, 0.85]) animals, $OR = 0.98$, $SE = 0.13$, $z = 0.17$, $p = 0.87$, 95% CI [0.76, 1.26].

Discussion

Although all trials required “reading” visual cues (e.g., determining if a cat appeared brave or playful), an orientation effect was specific to inferences from human eyes. Animal attribute decoding was better than complex emotion decoding (but not at ceiling), yet unaffected by orientation. Thus, even though orientation affected inferences about human eye regions regardless of ease in Experiment 2, it did not affect inferences of non-humans. This pattern parallels work showing orientation to affect inferring human-relevant traits (Wilson et al., 2018). Indeed, although the attributes in the animal trials *could* describe humans, they were not human-relevant in context. This pattern also parallels work showing that configural processing is more common to perceiving humans (Dahl et al., 2014; Hugenberg et al., 2016; S. Young, Tracy, et al., 2019). Overall, Experiment 3 suggests that inversion undermines sensitivity to cues regarding humans, rather undermining any attribute inference.

General Discussion

Although decoding complex emotions from eye regions involves "reading" visual cues (Baron-Cohen et al., 2001), the current work is of the first to demonstrate perceptual processes affecting this decoding. Using inversion to manipulate configural processing (Yin, 1969), better complex emotion decoding emerged from upright versus inverted eye regions (Experiments 1-3). Orientation effects extended to other inferences about human eye regions (Experiment 2) but not non-human animals (Experiment 3). These findings have important implications for interpersonal sensitivity, a domain where research on the effects of bottom-up factors on emotion perception often focuses on affective displays themselves (e.g., Smith et al., 2005). These findings also link to work showing orientation effects on evaluations characteristic of humanizing faces (e.g., Hugenberg et al., 2016). To the extent that humanizing faces relies on upright configurations (S. Young, Tracy, et al., 2019), upright configurations may affect sensitivity to complex emotions characteristic of humanness (Leyens et al., 2000).

Although we showed better complex emotion decoding from upright versus inverted eye regions, an open question regards what about upright configurations elicits better decoding. Configural processing may elicit biased attention to the eyes (Laidlaw, Risko, & Kingstone, 2012), making them especially salient. One possibility for why this configuration elicits better complex emotion decoding is thus that upright eyes better arrest attention and processing. Supporting this possibility, whereas perceiving upright versus inverted eye regions on entire faces facilitates recognizing direct versus inverted eye gaze, the same facilitation emerges when eye regions are shown alone (Senju & Hasegawa, 2006). Future work can test if complex emotions are more salient when eye regions are perceived upright.

The current findings raise important considerations for intergroup interactions because people have better complex emotion decoding for ingroup versus outgroup members (Adams et al., 2009; Stevenson et al., 2012). At the same time, ingroup versus outgroup faces are more likely to receive face-typical processing (e.g., Hugenberg & Corneille, 2009). Indeed, people look more at ingroup versus outgroup eyes altogether (e.g., Cassidy, Harding, Hsu, & Krendl, 2019) One possibility arising from the current work is that people are more sensitive to complex emotions from ingroup versus outgroup eyes because their eyes are more efficiently processed. Future work may examine this possibility.

Configural processing contributes to perceiving emotions (e.g., S. Young & Hugenberg, 2010). Using a validated manipulation, the current work provides novel evidence that configural processing affects sensitivity to complex emotions shown within specific facial features. Configural processing may thus extend from affecting sensitivity to basic emotions to the more complex emotions that make people uniquely human.

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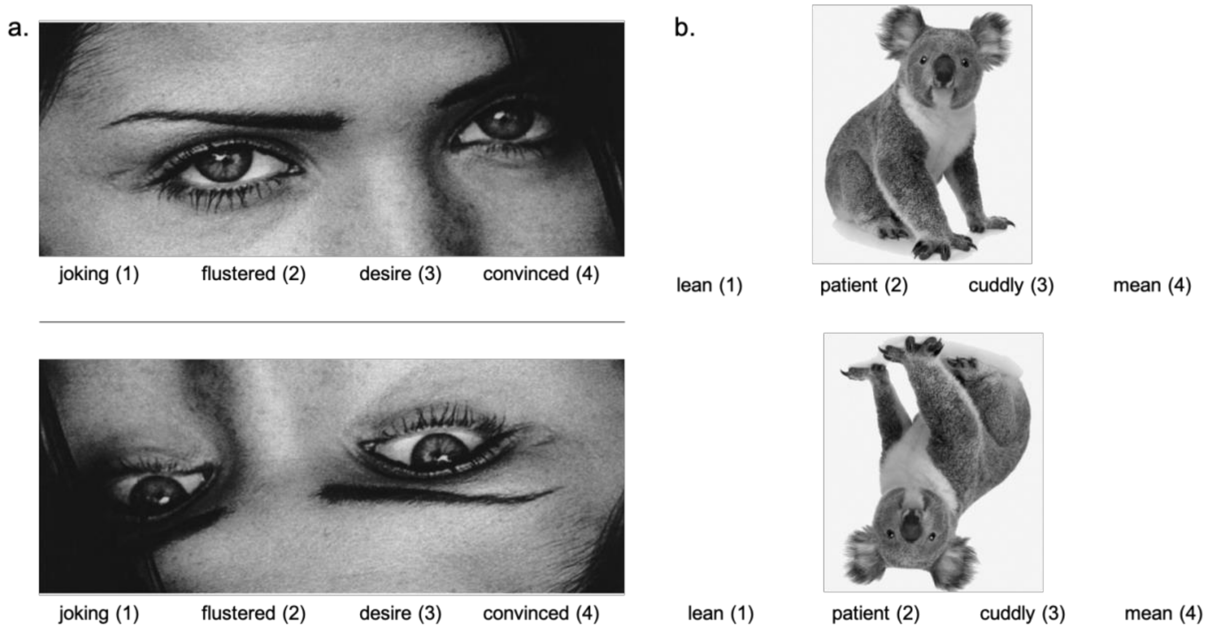

Figure 1. Examples of upright and inverted eyes trials in Experiments 1-3 (a) and animal trials in Experiment 3 (b).

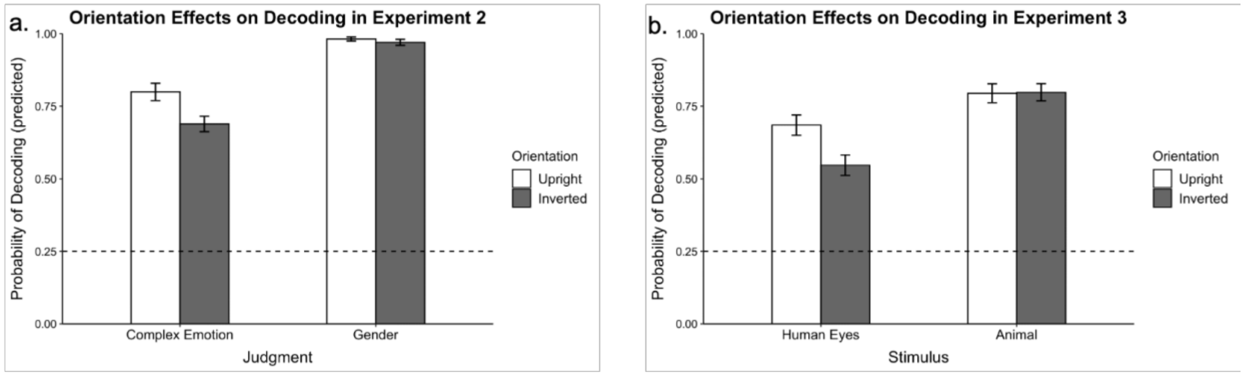

Figure 2. Orientation effects emerged when decoding complex emotions and gender from human eye regions in Experiment 2 (a). Orientation effects emerged when decoding complex emotions of human eyes, but not when decoding attributes of animals, in Experiment 3 (b). Dashed lines reflect chance-level performance.