Emotion

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Decoding Complex Emotions and Humanization Show Related Face Processing Effects

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Inferring others' complex emotions is central to ascribing humanness to others. However, little past research has investigated the perceptual processes linking the inference of complex emotions to judging others' humanness. To this end, we disrupted the low-level perceptual processes typically employed in face processing via face inversion. Of interest was whether the inversion-driven deficits in complex emotion judgments and in humanness judgments were related. In three experiments, we find that disrupting efficient face processing via face inversion undermined the accurate decoding of complex emotions from the eyes (Experiments 1a, 1b, and 2) and triggered more dehumanized evaluations of target eye regions (Experiments 1a and 1b) and faces (Experiment 2). Critically, these inversion effects on emotion decoding and dehumanization were positively correlated. People who demonstrated stronger inversion effects on the accuracy of decoding complex emotions also demonstrated stronger inversion effects on dehumanizing evaluations. Taken together, these findings provide novel evidence that sensitivity to complex emotions and (de)humanization are related through a shared perceptual basis in efficient face processing.

Keywords: face perception, eyes, emotion perception, secondary emotions, humanization

Supplemental materials: https://doi.org/10.1037/emo0000990.supp

Decoding others' complex emotions is a core aspect of social cognition. Such decoding facilitates interactions by allowing people to predict how others might behave (Baron-Cohen, 1994) while facilitating mentalizing processes (Waytz et al., 2010). Importantly, complex emotions are also linked to judging others as human. Indeed, perceivers often ascribe less sophisticated emotions to outgroups than to ingroups, a tendency known as *infrahumanization* (Leyens et al., 2003; Leyens et al., 2000). This tendency to see outgroups as lacking the emotional nuances of complex emotions is also linked to lowered prosocial intentions, implicating problematic intergroup relations (Cuddy et al., 2007). However, past work has focused primarily on the top-down (i.e., intergroup) motives that generate a broad ascription of emotional capacities to groups (e.g., they may feel physical pain, but we feel psychological ennui), rather than the perceptual processes that may link the accurate decoding of complex emotions to the tendency to (de)humanize other individuals. Of interest in the present work is whether the ability to accurately decode complex emotions from others' eyes is related to the tendency to ascribe humanness to them.

Past research has shown that face inversion challenges perceivers' ability to accurately extract nonverbal information from faces (e.g., Calder et al., 2000; S. Young & Hugenberg, 2010) and undermines the extent to which faces seem fully human (e.g., Cassidy et al., 2017; Hugenberg et al., 2016). Here, we investigate whether these inversion effects on complex emotion recognition and on humanness judgments are empirically linked. Whereas extensive theory has proposed that complex emotion perception is related to judgments of others' humanness due to top-down perceiver motives (e.g., Demoulin et al., 2009; Leyens et al., 2000; Leyens et al., 2001; Pereira et al., 2009; Rohmann et al., 2009), no research has tested whether these processes may have a shared perceptual basis.

To this end, we first briefly summarize theory implicating the decoding of complex emotions and (de)humanization. We then discuss the face inversion effect, as well as how the face inversion effect influences both complex emotion decoding and (de)humanization. Finally, we present three studies testing the shared perceptual basis of complex emotion judgments and dehumanization. We measure the effects of an inversion manipulation on performance on a well-validated measure of decoding complex emotions, the "reading the mind in the eyes" task (RME; Baron-Cohen et al., 2001) as well as evaluations of humanness that directly and conceptually replicate prior work (e.g., Hugenberg et

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al., 2016). We show that decoding complex emotions from the eyes and (de)humanization have positively related face processing effects.

Conceptual Links Between Complex Emotion Decoding and Humanness Judgments

Although a full review of dehumanization, infrahumanization, and related literatures (e.g., mind perception) is beyond the scope of the present work (see Haslam & Loughnan, 2014); all such models link inferences about humanness to inferences about emotions. Perhaps the most explicit model is *infrahumanization theory*, which argues that a consistent outcome of perceiving a group as lacking humanness is believing that the group lacks the ability for complex emotions (e.g., Rohmann et al., 2009). Indeed, people reliably describe dehumanized groups (Cuddy et al., 2007) as having less sophisticated emotions (e.g., Bain et al., 2009). Thus, whereas “they” may feel simplistic emotions such as anger or sadness, only “we” can feel indignation or ennui. Such effects have meaningful consequences. In the immediate aftermath of Hurricane Katrina, for example, people believed an outgroup (vs. an ingroup) victim experienced fewer complex emotions, a dehumanizing evaluation relating to a lesser likelihood of helping in relief efforts (Cuddy et al., 2007). Although this work supports the general premise that perceiving complex emotions may relate to evaluating humanness, no research has investigated a shared perceptual basis of such judgments. Tasks establishing this relationship (e.g., Leyens et al., 2000) have not asked people to decode complex emotions from visual displays. Instead, tasks ask whether people believe that others have the capacity to experience them. Indirect evidence, however, supports that decoding complex emotions and judging humanness are related through perceptual processing.

Inversion Effects on Complex Emotion Decoding and Humanness Judgments

Face inversion undermines complex emotion decoding and judgments of humanness. Inversion is a classic manipulation disrupting efficient face processing (Yin, 1969). When faces (e.g., Farah et al., 1998) or eye regions (e.g., Senju & Hasegawa, 2006) are inverted, people have difficulty recognizing and interpreting cues from them. Several mechanisms for this effect have been investigated. People show inversion effects when recognizing stimuli from familiar, but not novel, categories (Civile et al., 2014). Because people have extensive experience with upright faces, perceptual learning has been proposed as one contributor to inversion effects (Civile et al., 2019). If people learn to understand and individuate others in a specific orientation (i.e., upright), they may have difficulty doing so in a less familiar orientation (i.e., inverted). Other work suggests that the extent of inversion effects shifts based on where on faces people first attend, suggesting that how people initially allocate their attention determines the extent of inversion effects (Hills et al., 2011).

An issue of more longstanding debate is whether inversion qualitatively (A. Young et al., 2013) or quantitatively (e.g., Gold et al., 2012; Konar et al., 2010) changes face processing to elicit such effects. For example, whereas some theorists argue that upright cues broadly change processing to advantage face recognition (e.g., Tanaka & Gordon, 2011); other theorists suggest that cues are simply more efficiently extracted from upright faces (e.g., Sekuler et al., 2004). We take no position on this longstanding debate. Regardless of its precise mechanistic origins, the outcome of inversion is clear—it makes face processing less efficient. Critically, adjudicating this debate is not necessary to initially establish whether decoding complex emotions and humanness judgments show related face processing effects.

Inefficient face processing has multiple downstream consequences including both debilitating the decoding of emotions and judging others’ humanness. As an example of the former, Cassidy and colleagues (2021) used the well-established RME (Baron-Cohen et al., 2001); to show that face inversion undermines complex emotion perception. In the RME task, on each trial participants view an unfamiliar eye region displaying a complex emotion. Participants choose which of four emotions (one target and three foils) best reflects what that person is feeling. Cassidy and colleagues found that inverting the eye regions in the RME undermined participants decoding accuracy. This is notable because the RME is a commonly used measure of complex emotion decoding (e.g., Adams, Rule, et al., 2010; Stevenson et al., 2012). It is recommended by the NIMH to assess emotional perspective taking and has worldwide use (e.g., Vellante et al., 2013). Reading complex emotions from eyes requires cognitive (e.g., understanding emotion attributes) and perceptual (e.g., “reading” a state from visual cues) processes to reason about emotional states.

Prior work also indirectly supports that perceptual processes affect complex emotion decoding from the eyes. Indeed, merely seeing eyes enables emotion decoding (Adams & Kleck, 2003, 2005; Ganel et al., 2005) and mind attribution (Khalid et al., 2016; Looser & Wheatley, 2010; Schein & Gray, 2015). Decoding complex emotions from eyes also appears to upregulate activation in brain regions involved in face processing (Adams, Rule, et al., 2010). This latter finding suggests that manipulations that affect efficient face processing may extend to affect complex emotion decoding. Supporting this possibility, inversion impairs emotion identification from entire faces (e.g., Calder et al., 2000; S. Young & Hugenberg, 2010) and gaze judgments from eyes (Jenkins & Langton, 2003; Senju & Hasegawa, 2006; Vecera & Johnson, 1995). Inversion may thus undermine the ability of eye regions to cue the complex emotions that are characteristic of being humanized. Supporting this possibility, inversion undermines the tendency for expressive faces to appear to have sophisticated minds (Krumhuber et al., 2019). Taken together, there is good reason to believe that inversion affects complex emotion decoding.

A growing literature has also shown reliable inversion effects on (de)humanization. Hugenberg and colleagues (2016) showed that inverted (vs. upright) faces fail to activate humanlike concepts, undermine the categorization of human faces as human, and elicit lowered explicit ratings of humanness. Inversion undermines inferences about uniquely human characteristics but not about traits shared with animals (Wilson et al., 2018). This pattern of inversion undermining humanness occurs in both overt and speeded animacy judgments (Deska et al., 2016) and is exacerbated for evaluations of systematically dehumanized individuals (Cassidy et al., 2017). Put simply, when inverted faces fail to activate humanlike concepts, they elicit dehumanizing judgments (Deska & Hugenberg, 2017). Arising from this link is the proposal that face processing elicits (de)humanizing modes of perception affecting how we evaluate and act toward others (Fincher et al., 2017). Taken together, there is reason to believe that face processing and humanness judgments are linked. Not only do inverted human faces fail to elicit human-typical responses, but targets engaging in inhumane behavior fail to receive face typical processing (Fincher & Tetlock, 2016).

The Current Research

Existing theory supports links between complex emotion decoding and (de)humanization (Leyens et al., 2000), yet does not test the perceptual basis of this claim. Here, we seek to empirically connect these as yet disparate findings. We test the novel hypothesis that decoding complex emotions from the eyes and (de)humanization has a shared perceptual basis. Specifically, we hypothesize that inversion effects on complex emotion decoding and (de) humanization are positively related. Revealing positively related inversion effects would advance the literature by providing the first evidence that dehumanizing evaluations are directly associated with sensitivity to complex emotions. Such a finding would suggest that perceptual processes may not only affect evaluative biases in the extent to which people are perceived as animate, but relatedly affect sensitivity to understanding people's uniquely human inner lives.

We present three experiments directly supporting this hypothesis. First, we evince positively related inversion effects on decoding complex emotions and two evaluations characteristic of (de) humanization (Experiments 1a and 1b). We then replicate these effects with a more conservative test relying on a different set of facial stimuli (Experiment 2).

Experiments 1a and 1b

Experiments 1a and 1b had three goals. First, we sought to establish an inversion effect on decoding complex emotions from the eyes. Participants completed a RME (Baron-Cohen et al., 2001) modified to include upright and inverted eye-regions on a within-participants basis. We hypothesized better decoding of complex emotions for upright versus inverted eye regions. Second, we sought to conceptually replicate inversion effects on dehumanizing evaluations that used full faces (e.g., Hugenberg et al., 2016) using only eye regions. To this end, we operationalized (de) humanization by having participants evaluate eye regions on "humanness" after attempting to decode each complex emotion (Experiment 1a). We expected upright versus inverted eye regions to be evaluated as more humanlike. Our third and most novel goal was to link these effects by showing that people with stronger inversion effects on decoding complex emotions also had stronger inversion effects on (de)humanization. A positive relationship would be the first empirical demonstration of a shared perceptual basis for complex emotion decoding and judgments of humanness.

Although we were primarily interested in humanness evaluations because they are perhaps the most face valid evaluative dimension of humanity, we also wanted to determine the replicability of the expected effects. To this end, separate participants completed the same task but evaluated eye regions on their "mental sophistication" (Experiment 1b). Showing replicable effects would parallel inversion effects shown across multiple traits characteristic of (de)humanization (Hugenberg et al., 2016) and suggest that future work may examine these effects across evaluative contexts.

Method

Participants

Because work directly relating complex emotion decoding and humanness judgments of faces is novel, we did not have an a priori estimate of the size of this effect. For this reason, we selected a target sample size based on recent conceptually relevant work. Sample size was estimated based on work suggesting that having unique faculties is positively related to humanization using samples of 58 and 84 participants (Almaraz et al., 2018). We targeted 70 participants for each experiment because it reflected a midpoint between these sample sizes. We targeted the same sample size for both experiments because we had no a priori expectation that the expected effects would differ. Seventy people from Amazon Mechanical Turk (MTurk) participated in Experiment 1a (M_{age} = 40.20 years, SD = 15.29; $M_{\text{years of education}}$ = 15.17, SD = 1.82; 34 female). Fifty-six identified as White, six as Asian, four as Black, three as multiracial, and one as American Indian/Alaska native. Seventy different people completed Experiment 1b (M_{age} = 37.61years, SD = 10.51; $M_{\text{years of education}}$ = 15.09, SD = 2.48; 33 female). Fifty-six identified as White, six as Asian, six as Black, and two as multiracial. Participants followed task instructions ("Did you follow the instructions to the best of your ability?" rated from 1 [*not at all*] to 7 [*completely*]; M_{1a} = 6.80, SD_{1a} = .50; M_{1b} = 6.84, SD_{1b} = .40) and indicated they did not respond at random ("Did you make evaluations at random?" rated from 1 [*not at all*] to 7 [*completely*]; M_{1a} = 1.49, SD_{1a} = 1.39; M_{1b} = 1.39, SD_{1b} = .89). All experiments were approved by the University of North Carolina Greensboro and Indiana University Institutional Review Boards.

Materials and Procedure

Participants completed a self-paced, computerized version of the RME (Baron-Cohen et al., 2001). The RME consists of 36 grayscale images of eye regions that encompass the entire width of the face from mid nose to the brow. On each trial, participants viewed an eye region and four attributes (1 target and 3 foils) beneath it normed to ensure comparable emotional qualities (for further details, see Baron-Cohen et al., 2001). Participants selected the attribute best describing what the person was feeling. Of the 36 randomly ordered trials, orientation was counterbalanced in two versions, meaning each eye region identity was equally likely to be seen upright or inverted. Norms from recent work (Handley et al., 2019) suggested the items selected to be upright versus inverted (depending on version) did not differ in their difficulty, $t(34) = .29$, $p = .77$. Although most RME work examines decoding across all items, some work acknowledges that the depicted emotions vary in valence (e.g., Franklin & Zebrowitz, 2016). We had no a priori hypotheses regarding valence. However, our counterbalancing equated valence across orientation using norms from past work (Harkness et al., 2005). There were four positive, eight neutral, and six negative emotions in each orientation. Pilot testing suggested that inversion effects on decoding complex emotions did not vary by valence; thus, valence was not considered in the reported studies (see the online supplemental material for more details on pilot testing).

After selecting an attribute, participants saw a scale alone on the screen and made one self-paced rating: "How humanlike did the face seem?” (Experiment 1a) or “To what extent does this person seem mentally sophisticated?” (Experiment 1b) rated from 1 [*not at all*] to 7 [*very much*]. Humanness and mental sophistication are related constructs widely used in similar tasks to assess de(humanization) and mind perception (Gray et al., 2007; Hugenberg et al., 2016).

Results

Analytic Strategy

Because RME performance likely varies by participants and by items, we examined inversion effects in a series of mixed effects models regressing decoding (decoded = 1, not decoded = 0) and evaluation on inversion (upright = –1, inverted = 1). Models regressing decoding were logistic, and models regressing Evaluation were linear. These models included a random effects structure such that intercepts were expected to vary by participant and item and that Inversion effects were expected to vary by participant and item. Mixed effects models were built using the lme4 package (Bates et al., 2015) in R. For fixed and random effects, 95% confidence intervals (CIs) were estimated using the *confint* function from the lme4 package. Model *p* values were calculated using the lmerTest package (Kuznetsova et al., 2017). Estimated marginal means were obtained using the emmeans package (Lenth, 2018). 95% CIs for Kendall’s tau were estimated using the *kendall.ci* function from the NSM3 package (Schneider et al., 2020). 95% CIs refer to sizes of effects (i.e., betas or r_τ).

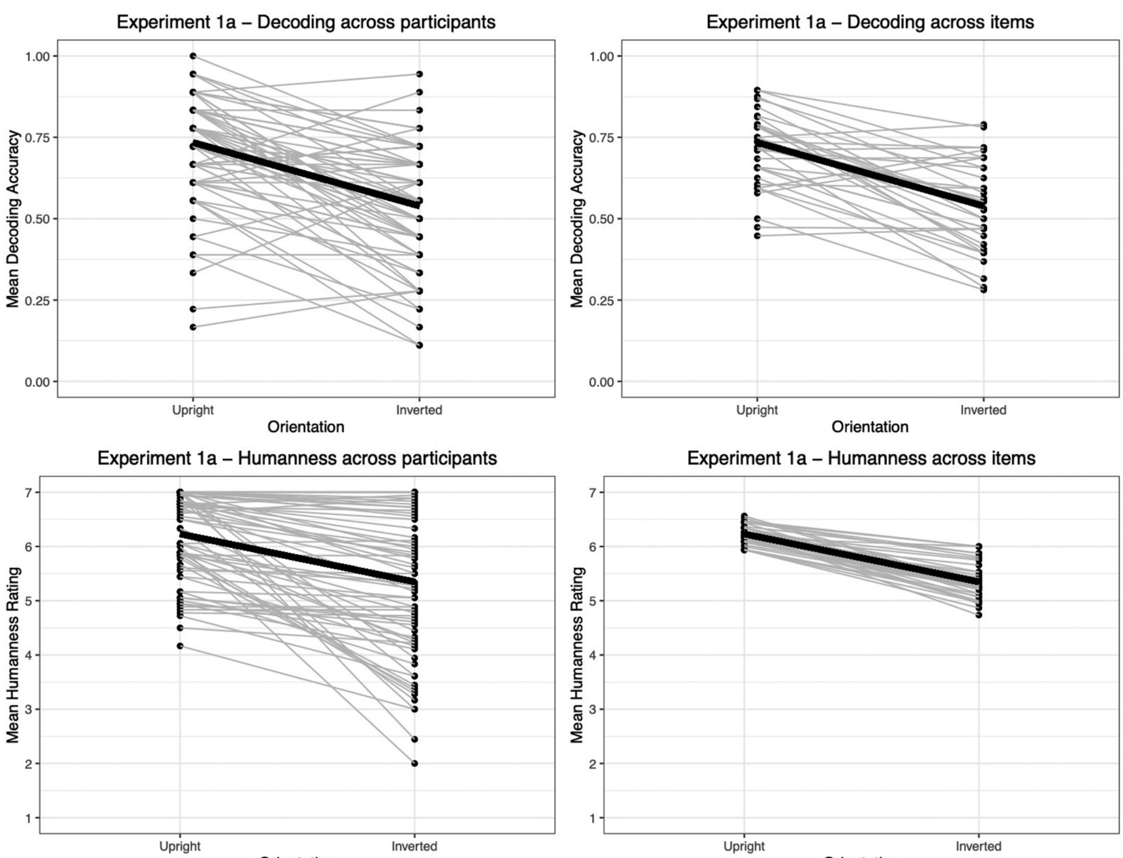
Inversion Effects on Decoding Complex Emotions

In Experiment 1a, the random effects structure showed significant variability across intercepts for participants (*SD* = .62, 95% CI [.46, .77]) and items (*SD* = .43, 95% CI [.28, .57]). Inversion effects varied significantly across participants (*SD* = .05, 95% CI [.02, .35]) and items (*SD* = .03, 95% CI [.02, .30]). A significant fixed effect of Inversion showed less likelihood of decoding complex emotions from inverted (model estimate = .54, *SE* = .03, 95% CI [.48, .60]) versus upright (model estimate = .73, *SE* = .03, 95% CI [.68, .78]) eye regions ($b = –.43$, *SE* = .06, $z = 7.00$, $p < .001$, 95% CI [–.55, –.32]). See Figure 1 for plots showing decoding accuracies and evaluations on a per-participant and per-item basis.

In Experiment 1b, the random effects structure showed significant variability across intercepts for participants (*SD* = .54, 95% CI [.39, .67]) and items (*SD* = .49, 95% CI [.30, .63]). Inversion effects varied significantly across participants (*SD* = .21, 95% CI

Figure 1

Plots Showing Decoding Accuracies and Evaluations on a per Participant and per Item Basis in Experiment 1a



Note. Light gray lines denote effects for each participant or item. Black lines denote the predicted effect from mixed effects models.

[.01, .33]) and items (*SD* = .19, 95% CI [.02, .29]). A significant fixed effect of Inversion showed less likelihood of decoding complex emotions from inverted (model estimate = .57, *SE* = .03, 95% CI [.51, .63]) versus upright (model estimate = .72, *SE* = .02, 95% CI [.67, .77]) eye regions ($b = -.33$, *SE* = .06, $z = 5.33$, $p < .001$, 95% CI [–.45, –.21]). See Figure 2 for plots showing decoding accuracies and evaluations on a per-participant and per-item basis.

Inversion Effects on (De)Humanization

In Experiment 1a, the random effects structure showed significant variability across intercepts for participants (*SD* = .97, 95% CI [.81, 1.14]) and items (*SD* = .16, 95% CI [.09, .20]). Inversion effects varied significantly across participants (*SD* = .53, 95% CI [.44, .63]) and items (*SD* = .08, 95% CI [.04, .12]). A significant fixed effect of inversion showed that inverted (model estimate = 5.35, *SE* = .17, 95% CI [5.01, 5.68]) versus upright (model estimate = 6.23, *SE* = .10, 95% CI [6.03, 6.43]) eye regions were evaluated as being less humanlike ($b = -.44$, *SE* = .07, $t = 6.58$, $p < .001$, 95% CI [–.56, –.30]).

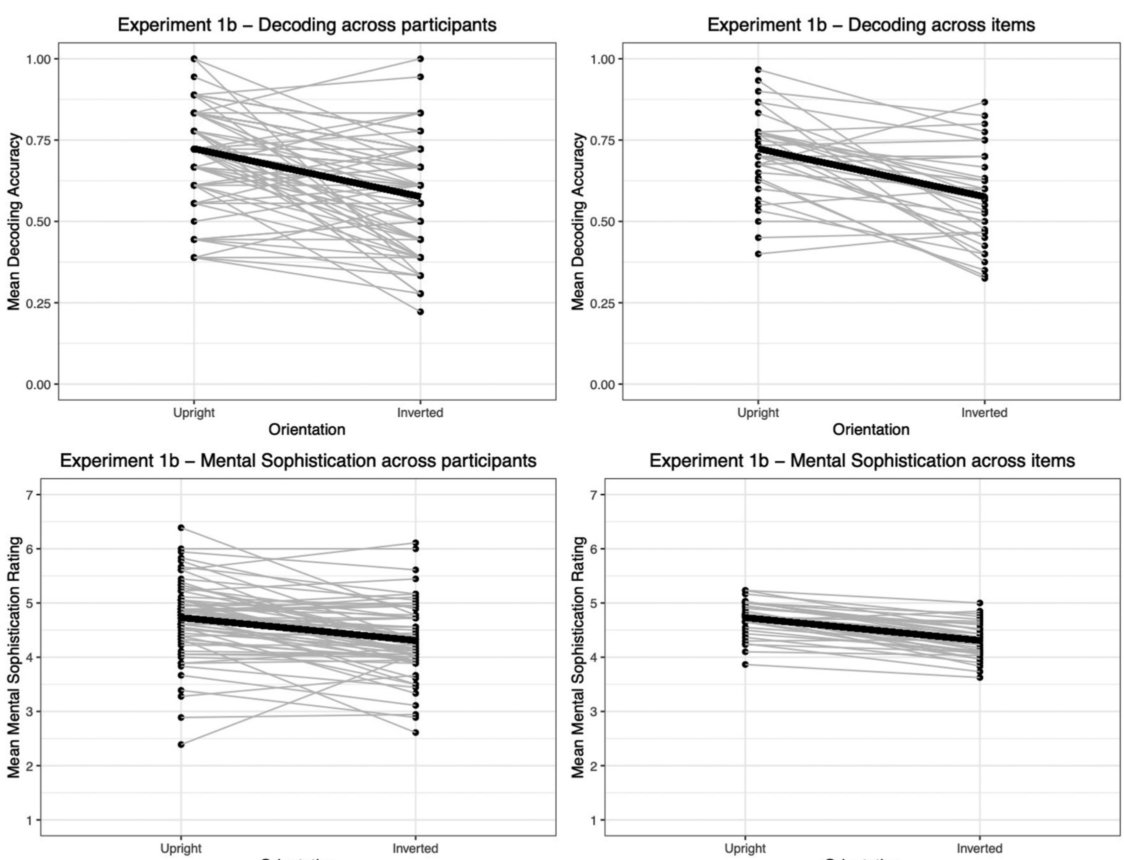
In Experiment 1b, the random effects structure showed significant variability across intercepts for participants (*SD* = .58, 95% CI [.47, .68]) and items (*SD* = .26, 95% CI [.18, .33]). Inversion effects varied significantly across participants (*SD* = .22, 95% CI [.15, .28]) and items (*SD* = .01, 95% CI [.001, .09]). A significant fixed effect of inversion showed inverted (model estimate = 4.31, *SE* = .09, 95% CI [4.13, 4.48]) versus upright (model estimate = 4.73, *SE* = .09, 95% CI [4.56, 4.91]) eye regions were evaluated as being less mentally sophisticated ($b = -.21$, *SE* = .03, $t = 6.04$, $p < .001$, 95% CI [–.29, –.15]).

Examining Related Inversion Effects

Of primary interest was whether inversion effects on complex emotion decoding and evaluations were positively related. To this end, we correlated participants' random slopes for Inversion from the model estimating decoding with their random slopes for Inversion from the model estimating evaluations. These estimates reflect how much each participant deviated from the population-level estimate for, respectively, inversion effects on complex emotion decoding and evaluations. We added the relevant model's fixed effect of Inversion (i.e., the population-level estimate) to each participant's random slope so these values could be interpreted in the context of the fixed effects of Inversion. A positive correlation would suggest that people estimated to have larger inversion effects on complex emotion decoding would also have

Figure 2

Plots Showing Decoding Accuracies and Evaluations on a per Participant and per Item Basis in Experiment 1b



Note. Light gray lines denote effects for each participant or item. Black lines denote the predicted effect from mixed effects models.

larger inversion effects on evaluations. We chose this method because it directly related to the above-described mixed effects models. For transparency, we include descriptive statistics and correlations on raw data in the online supplemental material.

We assessed these relationships using Kendall's tau because it is a nonparametric test robust to outliers and tied ranks. See the online supplemental material for an assessment of these relationships using Pearson's *r* and Spearman's rho. Significant positive relationships emerged between inversion effects on decoding and evaluations in Experiment 1a (r_τ = .20, *p* = .02, 95% CI [.04, .36]; see Figure 3a), and Experiment 1b (r_τ = .17, *p* = .04, 95% CI [.001, .33]; see Figure 3b). These relationships indicate that people with stronger inversion effects on complex emotion decoding had stronger inversion effects on (de)humanizing evaluations of the eye regions.

We next conducted two Monte Carlo analyses to determine the observed power we had to detect the positive relationship between inversion effects on decoding and evaluations in Experiments 1a and 1b. We used the *mvrnorm* function from the MASS package (Venables & Ripley, 2002) in R to simulate bivariate distributions of the inversion effects on complex emotion decoding and evaluations. Means, standard deviations, and correlations between the two effects matched those observed in the data (*N* = 2,000 simulations). The *p* value for Kendall's tau was obtained for each of these simulations with the *r.Test* function from the psych package (Revelle, 2018) in R. For Experiment 1a, the observed power was .7155 (i.e., 1,431 out of 2,000 simulations returned $p < .05$). For Experiment 1b, the observed power was .3785 (i.e., 575 out of 2,000 simulations returned $p < .05$).

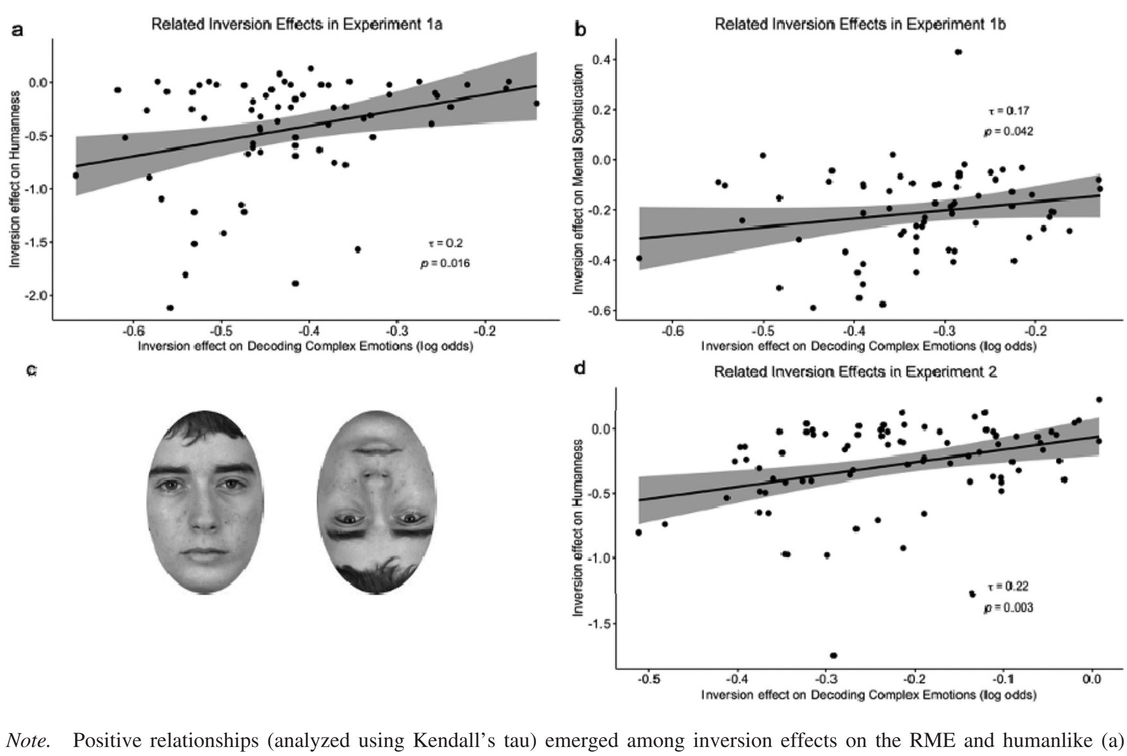
We also used Monte Carlo analyses to determine nonparametric *p*-values for Kendall's tau. We used the above procedure with one exception. Simulated distributions had a correlation between the two inversion effects equal to zero, which would be consistent with the null hypothesis of no significant relationships between the two inversion effects. The empirical *p* value was computed as $(r + 1)/(N + 1)$, where *r* refers to the rank of the observed Kendall's tau among all of the *N* = 2,000 randomly simulated values under the null hypothesis (see North et al., 2002). For Experiment 1a, this *p*-value was .01, similar to the parametric *p* value of .02. For Experiment 1b, this *p* value was .04, paralleling the parametric *p* value of .04. See the online supplemental material for visualizations of these analyses.

Discussion

Experiments 1a and 1b provided initial evidence that efficient face processing similarly affects decoding complex emotions and (de)humanization. When disrupting efficient face processing by inverting eye regions, people were less accurate in decoding

Figure 3

Inversion Effects on the RME Task in Experiments 1a, 1b, and 2



Note. Positive relationships (analyzed using Kendall's tau) emerged among inversion effects on the RME and humanlike (a) and mental sophistication (b) evaluations of eye regions in Experiments 1a and 1b. Example stimuli in the humanlike evaluations task of Experiment 2 (c). A positive relationship emerged between inversion effects on the RME and humanlike evaluations in Experiment 2 (d). RME = reading the mind in eyes task. Faces were used and adapted with permission from " The Chicago face database: A free stimulus set of faces and norming data" by D. S. Ma, J. Correll, & B. Wittenbrink, 2015, *Behavior Research Methods, 47*(4), pp. 1122–1135. Copyright 2015 by Psychonomic Society, Inc. Adapted with permission.

complex emotions from eye regions and evaluated those eye regions as being less humanlike (Experiment 1a) and mentally sophisticated (Experiment 1b). Less efficient face processing being linked to inaccuracy in decoding complex emotions from eye regions is consistent with work showing that inversion inhibits understanding cues from eye regions (Jenkins & Langton, 2003; Senju & Hasegawa, 2006). This finding extends work showing face processing contributions to primary emotion decoding (e.g., Calder et al., 2000; S. Young & Hugenberg, 2010) to include a broader array of complex emotions encountered and expressed in everyday life. More dehumanizing evaluations of inverted eye regions also replicates effects that, to date, have only been shown using entire faces (Cassidy et al., 2017; Deska et al., 2016; Hugenberg et al., 2016; Krumhuber et al., 2019; Wilson et al., 2018; S. Young et al., 2019). This finding also complements work showing the eyes to be especially important for perceiving animacy (Looser & Wheatley, 2010) by showing that the extent to which eye regions are efficiently processed elicits evaluations consistent with having an animate life.

Establishing that these effects are positively related in two independent experiments closes a conceptual loop between them by suggesting that they have a shared perceptual basis in efficient face processing. Indeed, this finding relates to work showing that dehumanized people are attributed fewer complex emotions (Cuddy et al., 2007; Leyens et al., 2000; Leyens et al., 2001) and are less likely be afforded face typical processing (Fincher & Tetlock, 2016). Yet, past research has only showed that people believe that dehumanized groups have fewer complex emotions, whereas Experiments 1a and 1b empirically show that the same manipulations that undermine actual decoding also undermine humanness. Experiments 1a and 1b advance a theoretical understanding of complex emotion decoding by suggesting that sensitivity to complex emotions in eyes and (de)humanizing evaluations of them similarly emerge via processes characteristic of efficient face processing. People do not only attribute fewer complex emotions to others when they think about dehumanized groups (e.g., Bain et al., 2009). People are also less likely to decode complex emotions from faces that they dehumanize.

Although the expected positive relationships between inversion effects emerged across experiments, it is important to note that the observed power to detect this relationship was stronger in Experiment 1a than Experiment 1b. One reason for this difference could be that, although statistically significant across experiments, the inversion effect on humanness evaluations was more pronounced than the effect on mental sophistication evaluations (see the online supplemental material). Although we had no a priori hypotheses about the strength of specific evaluative inversion effects, these findings suggest that inversion effects on evaluations may be heterogeneous to some extent. Speculatively, inversion effects might be strongest for evaluations with the most face valid interpretation of humanness. Alternately, perhaps perceivers make fine grained distinctions between having a humanlike essence and being mentally sophisticated (Fincher et al., 2018). Future work may consider the extent of these effects when determining sample sizes using evaluations that, although related to (de)humanization, may be more subtly affected by perceptual manipulations.

Experiments 1a and 1b showed consistent positive relationships between inversion effects on decoding complex emotions and (de)humanizing evaluations. One possibility is that this relationship emerged because the decoding and evaluative aspects of the task were yoked. That is, people evaluated eye regions immediately after attempting to decode their expressed complex emotions. If these constructs do share a perceptual basis in efficient face processing, a positive relationship between inversion effects should emerge even when using completely different emotion and humanness judgment tasks. By using different tasks, participants would be unable to potentially adjust evaluations based on decoding. Experiment 2 was designed to show whether the relationships shown in Experiments 1a and 1b are task dependent or potentially intrinsically linked. We thus deployed a more conservative test of our hypothesis in Experiment 2 by examining inversion effects where the decoding and evaluation tasks were completed in a random order and where the evaluation task comprised completely different human stimuli.

Experiment 2

The goal of Experiment 2 was to replicate Experiments 1a and 1b with a more conservative test. We focused on humanness evaluations given that it was of primary interest in Experiment 1 and because these evaluations reflect the more face valid measure of (de)humanization. In Experiment 2, participants completed two different tasks in a random order. One task was the RME described in Experiments 1a and 1b modified so that participants did not evaluate the humanness of each eye region. The other was a direct replication of Hugenberg and colleagues' (2016) Experiment 3, which showed inversion to trigger dehumanizing evaluations of full faces, rather than only eye regions. This test linking complex emotion decoding to (de)humanization is more conservative in that it employs different stimuli across tasks (that is, different faces in the RME and in the (de)humanization ratings), as well as uses different face regions (that is, the eyes only in the RME; full faces in the (de)humanization task). Replicating this link under these conditions would ensure the previous effects are not due merely to low level stimulus effects but are instead a more robust link between these phenomena.

Method

Participants

We targeted a comparable sample size to Experiments 1a and 1b but oversampled to ensure enough participants who had not previously participated in related lab experiments. Oversampling had the added benefit of potentially obtaining higher observed power for the expected positive relationship between inversion effects. Of 89 recruited MTurk participants, one was excluded for entering an incorrect survey code. Six were excluded for participating in related lab studies, leaving an analyzed sample of 82 participants (M_{age} = 37.73 years, SD = 11.66; $M_{\text{years of education}}$ = 14.35, SD = 2.55; 31 female). Sixty-six identified as White, one as Asian, 13 as Black, one as multiracial, and one as "other." Participants followed the task instructions (M = 6.62, SD = .78).

Materials and Procedure

Participants completed two tasks in a random order. One task was the RME described in Experiments 1a and 1b, except participants selected an attribute via mouse click and did not rate each eye region after attempting to decode a complex emotion.

The other task replicated Hugenberg and colleagues (2016) Experiment 3, which tested the extent to which inversion triggers dehumanizing evaluations of faces. In this task, participants viewed 40 White male faces from the Chicago Face Database (Ma et al., 2015) one at a time in a random order (see Figure 3c, e.g., faces). Orientation was manipulated within-participants and was counterbalanced across face identity such that each face was equally likely to be seen upright or inverted. Images were cropped to remove clothing and hair but preserved the entire face. The twenty faces selected to be upright (or, depending on version, inverted) and inverted (or, depending on version, upright) did not differ in their perceived age ($M_{\text{set 1}}$ = 25.89 years, SD = 5.70, $M_{\text{set 2}}$ = 28.33, SD = 6.05; t(38) = 1.32, p = .20) attractiveness ($M_{\text{set 1}}$ = 2.99, SD = .70, $M_{\text{set 2}}$ = 3.05, SD = .49; t(38) = .36, p = .72), trustworthiness ($M_{\text{set 1}}$ = 3.19, SD = .32, $M_{\text{Set 2}}$ = 3.28, SD = .34; t(38) = .90, p = .39), or facial-width-to-height ratio, ($M_{\text{Set 1}}$ = 1.87, SD = .13, $M_{\text{Set 2}}$ = 1.84, SD = .14; t(38) = .61, p = .55). On each trial, participants viewed a face at the center of the screen for 750ms. Participants then viewed a scale alone and made a self-paced humanness rating ("How humanlike did this face seem?" rated from 1 *[not at all]* to 7 *[extremely]*) via mouse click.

Having participants respond via mouse click resulted in some missing trials. On average, participants responded to 34.93 (SD = 2.57) RME trials. There was no difference in completed responses to upright (M = 17.48, SD = 1.53) versus inverted (M = 17.46, SD = 1.16) eye regions, t(81) = .13, p = .90. On average, participants responded to 39.77 (SD = .89) ratings trials. There was no difference in completed responses to upright (M = 19.88, SD = .53) versus inverted (M = 19.89, SD = .42) faces, t(81) = .33, p = .74. Experiment 2 used the same analytic strategy as Experiments 1a and 1b.

Results

For the model estimating decoding, the random effects structure showed significant variability across intercepts for participants (SD = .97, 95% CI [.77, 1.14]) and items (SD = .46, 95% CI [.29, .60]). Inversion effects varied significantly across participants (SD = .17, 95% CI [.03, .31]) and items (SD = .19, 95% CI [.04, .29]). A significant fixed effect of Inversion showed less likelihood of decoding complex emotions of inverted (model estimate = .47, SE = .04, 95% CI [.40, .53]) versus upright (model estimate = .57, SE = .03, 95% CI [.50, .64]) eye regions (b = –.22, SE = .06, z = 3.89, $p < .001$, 95% CI [–.33, –.10]).

For the model estimating evaluations, the random effects structure showed significant variability across intercepts for participants (SD = .93, 95% CI [.77, 1.12]) and items (SD = .12, 95% CI [.07, .16]). Inversion effects varied significantly across participants (SD = .37, 95% CI [.31, .43)] and items (SD = .05, 95% CI [.01, .09]). A significant fixed effect of inversion showed less humanlike evaluations of inverted (*model estimate* = 4.37, SE = .11, 95% CI [5.16, 5.58]) versus upright (*model estimate* = 5.93, SE = .11, 95% CI [5.71, 6.14]) eye regions, $b = -.28$, SE = .04, t = 6.30, $p < .001$, 95% CI [-.36, -.19]. See Figure 4 for plots showing per-participant and per-item decoding accuracies and evaluations.

Replicating Experiments 1a and 1b, these inversion effects were positively correlated, r_τ = .22, p = .003, 95% CI [.09, .36] (Figure 3d). We conducted a Monte Carlo analysis to determine the observed power we had to detect this positive relationship. Using the previously described procedure, the observed power for Experiment 2 was .8615 (i.e., 1,723 out of 2,000 simulations returned $p < .05$). We also used the previously described procedure to conduct a Monte Carlo analysis to determine a nonparametric p-value for Kendall's tau. For Experiment 2, this p-value was .003, paralleling the parametric p value of .003. See the online supplemental material for a visualization of this analysis.

Discussion

Experiment 2 conceptually replicated Experiments 1a and 1b by showing stronger inversion effects on complex emotion decoding positively related to inversion effects on (de)humanization. This relationship emerged even though the stimuli in each task were different and with a random task order. Sensitivity to complex emotions and (de)humanization may thus be linked through a shared basis in efficient face processing.

General Discussion

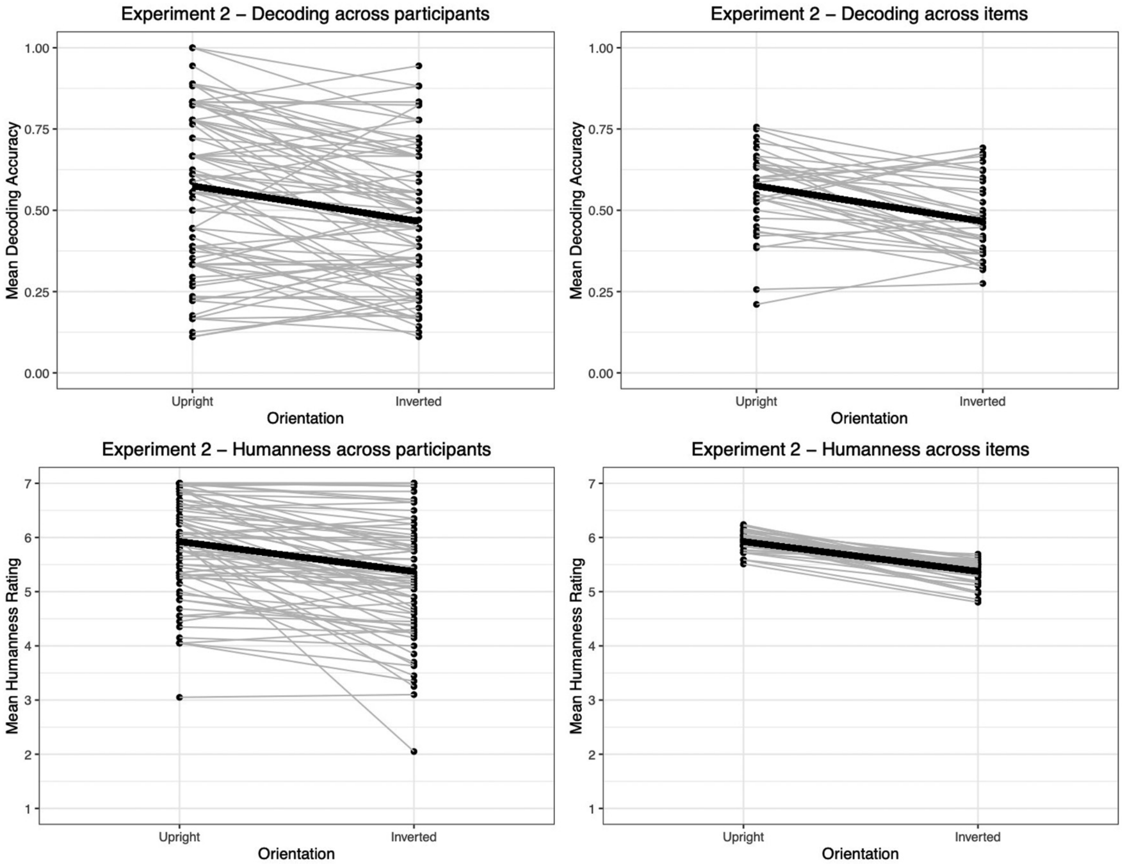
Using inversion to manipulate efficient face processing (Yin, 1969), we showed less likelihood of complex emotion decoding in inverted versus upright eye regions (Experiments 1 through 2) as well as dehumanizing evaluations of inverted versus upright eye regions (Experiments 1a and 1b) and faces (Experiment 2). These effects were positively correlated, suggesting that they are related through face processing mechanisms.

Past work has theorized that complex emotions and (de)humanization are related through motivated processes (Bain et al., 2009; Cuddy et al., 2007; Leyens et al., 2003; Leyens et al., 2001; Rohmann et al., 2009). For example, people highly identified with their groups overattribute complex emotions to ingroup versus outgroup members (Rohmann et al., 2009). The current work suggests that decoding complex emotions and (de)humanization are also related through face processing. One possibility is that even when people might not be motivated to dehumanize, differences in face processing (Hugenberg & Corneille, 2009) might similarly affect how perceivers understand and (de)humanize others. Notably, although we employ a perceptual manipulation, the present work does not rule out the possibility that motivations are engaged by the manipulation, nor does it suggest that the processes contributing to the observed relationships are mutually exclusive. Indeed, motivated and perceptual processes may affect each other during person perception (Freeman & Ambady, 2011). To determine the extent of a *unique* perceptual basis, future work may manipulate motivated and perceptual processes within the same experiments.

Notably, the Kendall's tau values observed across experiments left much unexplained variability. This suggests that processes beyond those underlying inversion affected the relationship between complex emotion decoding and (de)humanization. One possibility is that considering perceptual cues in tandem with top-down factors may explain more variability in this relationship. Another possibility is that more precise manipulations of specific perceptual processes may explain additional variability. For example, inversion effects may simultaneously reflect multiple processes, such as perceptual learning (Civile et al., 2019) and differential attention to specific features (Hills et al., 2011). It may be possible to explain more variability in the relationship between

Figure 4

Plots Showing Decoding Accuracies and Evaluations on a per Participant and per Item Basis in Experiment 2



Note. Light gray lines denote effects for each participant or item. Black lines denote the predicted effect from mixed effects models.

complex emotion decoding and (de)humanization by manipulating the theorized constituent processes underlying inversion effects. Such manipulations can reveal which underlying aspects of efficient face processing contribute to these related effects.

Whereas the current work provides the first evidence that (de) humanization stemming from inversion is associated with sensitivity to complex emotions, the causal direction of this relationship is unclear. These findings, however, lay groundwork to better characterize how people are (de)humanized. Because babies and adults attend more to the eyes than to other features (Baron-Cohen, 1994; Baron-Cohen et al., 1997) and also attend more to upright than to inverted faces (Turati et al., 2002), people may innately associate an upright orientation with humanness. If that is the case, one possibility is that encountering an upright orientation, or even upright orientations among eye regions, may trigger efficient face processing that affects later evaluations. Indeed, exploratory analyses (see the online supplemental material) suggested that decoding complex emotions may mediate an inversion effect on evaluations. Evaluative biases could emerge through relative sensitivity depending on how efficiently people processes faces.

Such a relationship is important to consider with regard to people systematically viewed as not being uniquely human (Cuddy et al., 2007). Inefficient processing of these faces (e.g., Hugenberg & Corneille, 2009); and dehumanizing evaluations of them (e.g., Cassidy et al., 2017) could simultaneously be linked to faces not being seen as experiencing "uniquely human" complex emotions (Leyens et al., 2001). Indeed, (in)sensitivity and evaluative bias have each been proposed to perpetuate discrimination toward the dehumanized (e.g., Black individuals; Lloyd & Hugenberg, 2021). We note, however, that the reported exploratory analyses should be treated with caution given current norms for interpreting mediational analyses (Smith, 2012). Future work may more directly assess these and other possible causal relationships between sensitivity and bias to further explore and clarify them.

Speculatively, the link between efficient face processing and (de) humanization might also contribute to problematic intergroup interactions (e.g., Trawalter & Richeson, 2006) and link to longstanding injustices (Kawakami et al., 2017). A nonverbal "language of the eyes" is critical for adaptive communication (Adams, Ambady, et al., 2010), and dehumanized groups elicit less attention to eye regions critical to emotion judgments (Friesen et al., 2019). Relatedly, dehumanizing judgments and treatment emerge in everyday life (Kteily & Bruneau, 2017); with some groups and faces being seen as "less evolved" (Petsko et al., 2020). One possibility is that these faces are visualized in dehumanizing ways because their mental states are not well understood. Further, insofar as empathy toward dehumanized groups is undermined, these dehumanizing cognitions can have real impact (Cuddy et al., 2007). Future work may benefit from also manipulating perceivers' motivation to enhance mental state understanding alongside perceptual cues. Such combinations may benefit our understanding of behavior toward historically dehumanized groups. Indeed, dehumanizing associations with Black individuals are related to endorsing violence against Black suspects (Goff et al., 2008). If people do not understand the emotions of these suspects, it may be easier to endorse such dehumanizing violence.

Despite the advances afforded by the current work, one limitation is that these experiments used participants from an online pool. Whereas online pools are advantageous when current events prevent in-person experiments, it is difficult to monitor whether participants had questions about the task or to objectively assess whether they followed instructions. Further, differences screen settings (e.g., luminance) might unduly affect performance. However, given the within-subjects nature of our studies, our effects are difficult to attribute to these between-participants variations. Further, even though the standard RME instructions are straightforward and the terms used in our evaluations (e.g., "humanlike") are reliably interpreted through the lens of (de)humanization (Hugenberg et al., 2016); we cannot rule out that the possibility of such variability affecting our findings. Further, using one population raises concerns regarding whether findings would generalize to a broader swath of people. To the latter point, our findings conceptually (Experiments 1a and 1b) or directly (Experiment 2) replicated work using participants from a variety of locations (e.g., Hugenberg et al., 2016; Wilson et al., 2018) and populations (e.g., Cassidy et al., 2017), suggesting that the sampled participants performed similarly to those tested within the laboratory environment. Although generalizing these findings to a variety of populations is important, that related effects have been shown using different regions and databases suggests, albeit indirectly, their generalizability.

The items in the RME also vary in their difficulty (Fernandez-Abascal et al., 2013), raising the possibility that performance on specific items might unduly drive effects rather than the inversion manipulations. Although participants, on average, reported attending to the task, we cannot rule out the possibilities that some participants did not understand the task or that some items were more difficult than others. Our analytic strategy, however, helped to account for such limitations by treating participants and items as random factors and by allowing inversion effects to randomly vary by participant and by item. That replicable and positively related inversion effects on complex emotion decoding and (de)humanization emerged beyond these random effects supports that the present findings can be attributed to our manipulation.

The current work relied on the RME to quantify complex emotional state decoding. Although recommended by the NIMH to assess emotional perspective taking, the RME is not without limitations. For example, sociocultural factors affect decoding, which poses a challenge when assessing decoding in clinical populations (Dodell-Feder et al., 2020). The RME does, however, confer several benefits. First, it is easy to administer and interpret. Second, that the RME uses eye regions makes it well-suited for a straightforward inversion manipulation. Third, decoding measured by the RME corresponds to expected behavior, relating negatively to autistic traits (Baron-Cohen et al., 2001) and positively to prosocial intentions (Declerck & Bogaert, 2008).

Efficient face processing enables mind (Deska et al., 2016) and emotion (Calder et al., 2000; Krumhuber et al., 2019) perception. Within faces, however, the mere presence of eyes triggers the perception of humanlike minds (Looser & Wheatley, 2010). The current work provides novel evidence that efficient face processing relatedly affects decoding complex emotions and (de)humanization. Efficient face processing may thus extend from subserving the perception of a mind to relatedly subserve sensitivity to that mind's inner workings.

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