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BELIEVING IS SEEING: ARBITRARY STIGMA LABELS AFFECT THE VISUAL REPRESENTATION OF FACES

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Unconcealable stigmas negatively affect how people visually represent faces. The current work extends these findings to arbitrary labels implying that targets are stigmatized (e.g., depressed). Faces labeled as depressed elicited more negative (i.e., sad and angry) visual representations (Studies 1a, 1b, and 2) than healthy faces. These representations were unaffected by paired neutral or negative behaviors unrelated to depression (Study 1a). Less stigmatizing labels (e.g., having migraines) did not consistently yield more negative representations (Studies 1b and 2) versus healthy-labeled faces, suggesting a stigma-related negativity bias in visual representations. Arbitrary stigma labels also elicited increased brain activity associated with visual processing (Study 3) that was exacerbated by negative versus neutral paired behaviors. These findings suggest that, despite similar behavioral responses, available behavioral cues may impact mechanisms underlying the visual processing of stigmatized targets. Together, these findings evince that arbitrary stigma labels fundamentally change how faces are visually processed and represented.

Keywords: stigma, negativity bias, stereotyping, face perception, social neuroscience

Elucidating mechanisms underlying how people perceive stigma (traits or characteristics that make an individual devalued; Goffman, 1963), has been a key goal of social psychological research. Stigma is rapidly detected (Krendl, Zucker, & Kensinger, 2017) and negatively impacts its targets (for a review, see Major & O'Brien, 2005). An emerging body of research suggests that faces may be dissociated on the basis of being stigmatized during visual processing (Stolier & Freeman, 2015).

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Specifically, faces that indicate that someone has a stigmatized condition (e.g., on the basis of race or ethnicity) are visually represented in more negative and stereotypic ways than are non-stigmatized faces (e.g., Dotsch, Wigboldus, Langner, & van Knippenberg, 2008). Although this work has been limited to unconcealable sources of stigma (e.g., race, age, or gender; Stolier & Freeman, 2016b), many stigmas are concealable (e.g., mental illness; Quinn & Chaudoir, 2009) and pose considerable stressors and psychological challenges to afflicted individuals (Pachankis, 2007). It remains unknown whether stigma elicits differential visual processing and representations in the absence of stigma-related attributes on faces.

Because some stigmatized conditions are concealable, individuals may be labeled as having a concealable and stigmatized condition even if that is untrue. These labels may thus yield negative consequences for targets. For example, individuals merely implied to have a stigmatizing condition engage in the same strategies to manage the consequences of being perceived to have that condition (Blinde & Taub, 1992) and demonstrate similar psychosocial difficulties (Bhattacharya, Barton, & Catalan, 2008) as people who actually have a stigmatizing condition. Because these findings suggest that being labeled as having a stigmatized condition alters how individuals behave, it allows for the intriguing possibility that arbitrary stigma labels may also change how perceivers visually process these targets. That is, even the thought that a person has a stigmatizing condition might be enough to modulate visual processing. If this were the case, it would suggest that stigmatized labels fundamentally influence person perception. The present work thus examined whether arbitrarily labeled stigma (e.g., a label identifying an individual as having a stigmatized condition, irrespective of the label's accuracy) shifts how people visually process and represent faces at both the behavioral and neural levels.

Arbitrary stigma labels may affect visual processing because cognitive and perceptual signals intersect during perception (Albohn & Adams, 2016; Balcetis & Dunning, 2006; Bar, 2003; O'Callaghan, Kveraga, Shine, Adams, & Bar, 2017; Oliva & Torralba, 2007). This intersection impacts how perceivers evaluate stereotypicality (Alter, Stern, Granot, & Balcetis, 2016; Caruso, Mead, & Balcetis, 2009) and valence (Cole, Trope, & Balcetis, 2016; Epley & Whitchurch, 2008; Ratner, Dotsch, Wigboldus, van Knippenberg, & Amodio, 2014) in their visual representations. For example, social contexts (e.g., Krosch & Amodio, 2014) and beliefs (e.g., Caruso et al., 2009) affect White perceivers' visual representations of Black faces so that they appear more or less racially stereotypic (i.e., prototypically Black). One way stigmatized targets could thus be represented is by appearing more stereotype-consistent. We posited that arbitrarily labeling faces as having a stigmatized condition would elicit more stereotype-consistent visual representations than faces given a non-stigmatizing label. Alternatively, more stereotypic representations may represent a broader negativity bias in stigma-related visual representations. That is, targets could be visually represented in a more negative manner more broadly. Indeed, prior work suggests that target faces are visually represented more negatively (e.g., as less attractive) when they are perceived to pose a threat to perceivers

(Cole et al., 2016). Moreover, perceiving stigmatized individuals elicits broadly negative emotions (Harris & Fiske, 2006; Jones et al., 1984; Weiner, Perry, & Magnusson, 1988). Critically, either possibility (greater stereotypic representations or a general negativity bias) would demonstrate that merely suggesting that a person is stigmatized could change how a person is perceived and potentially lead to consequences that negatively impact how that person is treated.

Group knowledge (for a review, see Stolier & Freeman, 2016a) and out-group membership (Xiao, Coppin, & Van Bavel, 2016) affect how faces are visually processed. However, it is unclear if these are stigma-specific effects or if they represent a broad negative cue effect on visual representations. That is, might any kind of negative cue, whether stigma-related or not, impact visual processing? Disentangling these possibilities can clarify why stigma affects visual processing. As a secondary goal, we examined whether visual representations differed when arbitrary stigma labels were combined with stigma-unrelated negative or neutral behavioral information (Studies 1a and 3). This is an important consideration because it provides insight into the extent to which any negative cue might affect visual representations. If stigma-related cues specifically affect visual representations, the implication that one has a stigmatized condition should elicit similarly stereotypic-specific or broadly negative visual representations regardless of a paired behavior's valence. At the same time, negative behaviors are highly salient (Rozin & Royzman, 2001) and influence impression updating over neutral behaviors (Mende-Siedlecki & Todorov, 2016). If any negative cue elicits more negative representations, stigma-labeled faces paired with stigma-unrelated negative versus neutral behaviors should elicit the most negative representations.

Over four studies, we manipulated stigma by arbitrarily labeling targets as having depression. Depression is highly stigmatized (Corrigan, 2004) and concealable (Quinn, 2006), meaning that it can be arbitrarily labeled. Depression is also the most common mental illness in the United States (National Institute of Mental Health [NIMH], 2012), making it a relevant and familiar stigmatized identity. Finally, there are many well-known negative stereotypes associated with depression (e.g., sadness; Monteith & Pettit, 2011), thereby allowing us to dissociate if visual representations of ostensibly depressed faces are skewed in a stereotypic or generally negative manner. Specifically, we tested if arbitrarily labeled stigma (i.e., being labeled as having depression) would elicit more stereotypic (Studies 1a–b) or more broadly negative visual representations (Study 2) of targets. In Study 3, we used functional magnetic resonance imaging (fMRI) to identify the neural mechanisms underlying these visual representations. As a secondary goal, we tested if visual representations and processing differed by stigma-unrelated negative or neutral behavioral information paired with faces (Studies 1a and 3). Determining if one or both of stigma labels and stigma-unrelated behaviors affect visual representations can provide initial insight into the emergence of a stigma-specific or a broader negative cue effect on visual representations and processing.

STUDY 1A

Prior work has shown that stigmatized conditions that are apparent from visible cues elicit stereotypic visual representations of faces (e.g., Krosch & Amodio, 2014). Study 1a used a perceptual downgrading paradigm to extend these findings to arbitrarily labeled stigmatized conditions. Perceptual downgrading assesses perceivers' tendency to visually represent faces differently than they objectively are in certain contexts (e.g., if a target represents a threat; see Cole et al., 2016). We predicted faces arbitrarily labeled as being depressed (versus healthy) would be visually represented in a more stereotypic way. Specifically, we predicted that depressed individuals would be perceptually downgraded to appear sad, a stereotype strongly associated with depression (Monteith & Pettit, 2011).

We also explored if behavioral information qualified this effect. Two possibilities emerged: If stigma (e.g., being labeled as having depression) specifically yields stereotype-consistent representations (e.g., looking sad), it should elicit similarly stereotypic representations regardless of a paired behavior's valence. However, if any negative cue elicits more negative representations (that here, would be consistent with a stigma-related stereotype), stigma-labeled faces paired with stigma-unrelated negative versus neutral behaviors should elicit the most negative (i.e., saddest) representations.

METHOD

Participants

Two hundred individuals (M_{age} = 35.83 years, SD = 11.49 years, 19–69 years, 106 female) recruited from Amazon Mechanical Turk provided informed consent and were compensated $.40. Power analyses (PANGEA; for details see www.jakewestfall.org/pangea/) using a small effect size d = .20 and alpha = .05 targeted 200 participants for 80% power to detect a main effect of Diagnosis. The Indiana University Institutional Review Board approved this study.

Stimuli

To measure perceptual downgrading, we created stimuli following procedures described in past work (Cole et al., 2016; Epley & Whitchurch, 2008) and summarized here. Four neutrally expressive Caucasian male faces were selected from the Radboud Faces Database (Langner et al., 2010). Using Abrasoft Fantamorph software, we morphed these faces with the same male face randomly generated by FaceGen Modeller Core 3.14 that we had manipulated to have a sad or a happy expression. We generated the sad expression by changing the FaceGen expression settings "sad" to 100% and "lip corner depressor" to 30%. We generated the happy expression by changing the FaceGen expression settings "smile closed" to 100%, modified smirk left to 30%, and modified smirk right to 30%. For each face, we generated five morphs with the sad face and five morphs with the happy face. The

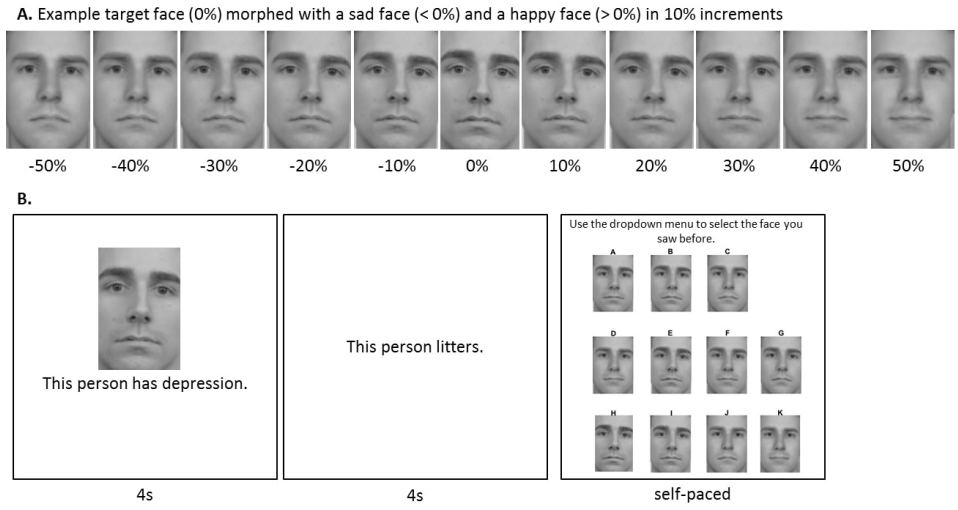

FIGURE 1. Example target face (0%) and morphs (sad: < 0%; happy: > 0%; A) and an example trial (B) used in Study 1a.

morphing procedure involves matching points on a target's face with identical points on any exemplar face. This process creates a continuum of faces in which facial features are blended together ranging from 100% target to 100% exemplar.

Like prior work (Cole et al., 2016; Epley & Whitchurch, 2008), we extracted images from this continuum that represented the target morphed with the sad or happy face at 10% increments. The faces ranged from a morph that was 50% of the target and 50% of the sad face to 50% of target and 50% of the happy face (Figure 1a). For instance, an image labeled as -10% reflects a face containing 90% of the target and 10% of the sad face.

Procedure

After providing informed consent, participants read that they would complete a task in which they would learn information about four different people. There were four trials in the task (see Figure 1b for an example trial) in which participants viewed each of the four faces once. Prior work has used a similar number of trials (e.g., 1–4 trials) to assess perceptual downgrading (e.g., Cole et al., 2016). The trials were presented in a random order. On each trial, a face was paired with a statement that read, "This person has depression" or "This person is healthy," for four seconds on the screen. On the next screen, participants read one of four behavioral sentences about the person for four seconds. Two of the behaviors were negative ("This person litters" or "This person is always late") and two were neutral ("This person drives a red car" and "This person goes to sleep at 11:00"). These behaviors were chosen because they were designed to merely be negative and neutral (thus unrelated to depression) and on the basis of norms from past work (Somerville, Wig, Whalen, & Kelley, 2006). Participants then viewed an array of 11 faces presented in a random order and that was comprised of the original face, the five

faces ranging from 10% to 50% morphs with the sad face, and the five faces ranging from 10% to 50% morphs with the happy face. Participants were instructed to select which face they perceived to be the original face using a dropdown menu. Participants were randomly assigned to complete one of eight counterbalanced versions of the task, meaning that all potential face-diagnosis-behavior pairs were represented across versions. This design allowed us to examine whether visual representations differed from the true face based on arbitrary stigma labels.

After the perceptual downgrading task, participants completed a matching task. The purpose of the matching task was to measure attention to the stimuli during the perceptual downgrading task. By measuring how accuracy on the matching task affected the perceptual downgrading data, we assessed if potential effects of stigma or behavioral valence on perceptual downgrading could be attributed to attentional differences to the stimuli. Images of the four faces used in the trials were shown at the top of the screen. Participants were instructed to match two items with each person based on the information in the task. They were told that one item must be a diagnosis (healthy, depression, or migraines) and that one item must be a behavior ("This person always litters," "This person is always late," "This person drives a red car," "This person goes to sleep at 11:00," This person is a loyal friend," or "This person respects others").

After the matching task, participants used 7-point scales (1 = not at all to 7 = completely) to rate stereotypes of depressed individuals ("Are people who are depressed stereotyped as sad?" and "Are people who are depressed stereotyped as threatening?"). These questions were presented in a random order. Participants then provided demographic information. Last, participants responded yes or no to indicate if they had ever been diagnosed with depression. Of 200 participants, 143 had no prior depression diagnosis, and 57 had a prior diagnosis. Being previously diagnosed with depression did not affect the perceptual downgrading results (see below). All results thus refer to the full sample.

RESULTS

Stereotype Endorsement

We first examined if participants endorsed that depressed people are stereotyped as sad. To do this, we compared the mean response to the midpoint of the scale, which would indicate moderate stereotype endorsement. Scores larger than the midpoint indicate strong endorsement. A one-sample *t*-test comparing sadness ratings ($M = 5.77$, $SD = 1.34$) to the scale midpoint verified that participants endorsed depressed people being stereotyped as sad, $t(199) = 18.68$, $p < .001$, $d = 1.32$, 95% CI [1.13, 1.51]. Threat ratings ($M = 3.07$, $SD = 1.62$) fell below the midpoint, $t(199) = 8.15$, $p < .001$, $d = .58$, 95% CI [.43, .73].

TABLE 1. Mean (Standard Deviation) Scores from Studies 1a, 1b, and 2

A. Study 1a: Sad to happy morphs	Depression (%)	Healthy (%)	Overall Behavioral Valence (%)
Negative	-8.35 (24.01)	-.45 (23.52)	-4.40 (16.31)
Neutral	-7.15 (22.83)	.80 (23.58)	-3.18 (17.00)
Overall Diagnosis	-7.75 (16.18)	.18% (17.75)	-3.79 (12.32)
	Depression	**Healthy**	**Migraines**
B. Study 1b: Sad to happy morphs	-6.29 (14.88)	-2.82 (18.17)	-9.36 (14.26)
C. Study 2: Angry to happy morphs	-5.77 (15.45)	.71 (16.09)	-1.38 (15.43)

Note. Scores Range from -50% (saddest or angriest morph selected) to 50% (happiest morph selected).

Perceptual Downgrading

We coded selected faces based on the percentage of the happy or sad face morphed with the target. The score for each trial could range from -50% (saddest) to 50% (happiest), with the score for selecting the original face being 0%. Each participant had four scores (one per trial). We entered scores into a 2 (Diagnosis: depression, healthy) × 2 (Behavioral Valence: negative, neutral) repeated-measures ANOVA (see Table 1a for descriptive statistics). Suggesting perceptual downgrading, a main effect of Diagnosis emerged, $F(1, 199) = 22.98$, $p < .001$, $\eta_p^2 = .10$, 95% CI [.04, .19]. Participants represented faces arbitrarily labeled as depressed versus healthy to be sadder. There was no effect of Behavioral Valence, $F(1, 199) = 0.60$, $p = .44$, $\eta_p^2 < .01$, 95% CI [.00, .04] and no Diagnosis × Behavioral Valence interaction, $F(1, 199) = .001$, $p = .99$, $\eta_p^2 < .01$, 95% CI [.00, .0001]. All effects maintained direction and significance when including Participant Depression Diagnosis as a between-groups factor in the ANOVA. Moreover, Participant Depression Diagnosis had no influence as a main effect or in interactions with Diagnosis or Behavioral Valence, *p*s > .21.

Matching Task

Participants had 67.25% accuracy (*SD* = 25.51%) on matching diagnoses and 42.13% accuracy (*SD* = 33.40%) on matching behaviors to faces. Because diagnosis accuracy was higher than behavior accuracy, $t(199) = 11.01$, $p < .001$, $d = .85$, 95% CI [.69, 1.04], participants may have not paid attention to behaviors to the same extent as diagnoses, allowing for a stronger Diagnosis than Behavioral Valence effect in the perceptual downgrading task. To address this possibility, we re-analyzed the perceptual downgrading data including Matching Task Accuracy (above 75%, below 75%) as a between-groups factor in the above-described ANOVA. Fifty-nine participants had accuracy above 75% and 141 had accuracy below 75%. All effects maintained direction and significance. Matching Task Accuracy had no influence as a main effect or in interactions with Diagnosis or Behavioral Valence, *p*s > .54. The described Diagnosis effect is thus unlikely to be due to attentional differences to the stimuli.

DISCUSSION

Study 1a provided initial evidence that perceivers visually represent faces arbitrarily labeled as having a stigmatized condition in a stereotypic way. Specifically, perceivers visually represented faces arbitrarily labeled as depressed as sadder than they objectively were. However, perceivers did not downgrade (nor upgrade) representations of faces arbitrarily labeled as healthy. Instead, perceivers accurately identified the original faces. This finding extends work showing that social contexts (Krosch & Amodio, 2014), beliefs (Caruso et al., 2009), and stereotypes (Alter et al., 2016) yield stereotypic representations of faces associated with unconcealable stigmas to stigmatized conditions whose presence is implied by an arbitrary label.

Whereas arbitrarily labeled stigma elicited stereotypic visual representations, paired behavioral information did not qualify this effect. Beyond possibilities rooted in methodological limitations (e.g., using few trials in the perceptual downgrading task), one possibility for a lack of behavioral cue effects is that downgraded visual representations may be attributed to stigma-specific, but not generally negative, cues. However, the data do not provide conclusive evidence of this possibility. For instance, stigma-unrelated cues might more strongly impact representations if they reflect more extreme negative behaviors (e.g., murder versus littering). Indeed, negative behaviors varying in their diagnostic value differentially impact impression updating (Mende-Siedlecki, Baron, & Todorov, 2013). It is also possible that pairing multiple pieces of behavioral information with faces or increasing the number of trials could yield stronger or more stable effects of behavioral information on visual representations. Regardless of these possibilities, however, the current work suggests that common negative behaviors may not modulate visual representations to the same extent as common stigma labels.

One question from Study 1a was if sadder visual representations of depressed versus healthy faces were specific to stereotypes of highly stigmatized conditions (e.g., sadness being strongly stereotypic of depression) or if they were due to the negativity generally associated with having any illness. Disentangling these possibilities is important to inform when stigma-related cues are likely to affect visual representations of faces. Study 1b addressed these possibilities.

STUDY 1B

In Study 1a, arbitrary stigma labels elicited stereotype-consistent visual representations of target faces. Study 1b replicated Study 1a and included migraines as an illness sharing many evaluative characteristics with depression. Depression and migraines are perceived to be similarly familiar, emotionally intense, and treatable (Krendl & Cassidy, 2017). We predicted faces labeled as depressed would be represented as sadder than faces labeled as healthy (thereby replicating Study 1a). We included migraines to resolve two possibilities. First, if downgrading effects depend on sadness being strongly stereotypic of depression, faces arbitrarily la-

beled as depressed should be represented as sadder than faces arbitrarily labeled as migraine-afflicted. Indeed, we expected sadness to be endorsed as more stereotypic of depression than of migraines. This pattern would suggest that stigma impacts visual representations in a stereotype-consistent way. Second, if labeling faces with any illness negatively shifts their representations, arbitrarily labeled depressed and migraine-afflicted faces should be similarly represented as sadder than faces labeled as healthy.

METHOD

Participants

Two hundred individuals recruited from Amazon Mechanical Turk provided informed consent and were compensated $.40. One participant was excluded for not responding in the perceptual downgrading task and 14 because they had participated in Study 1a. The final sample comprised 185 participants (M_{age} = 36.84 years, *SD* = 10.90 years, 19–66 years, 93 female).

Stimuli and Procedure

Study 1b replicated Study 1a with the following changes. Sad to happy morphs of two additional neutrally expressive Caucasian male faces selected from the Radboud Faces Database (Langner et al., 2010) were created in the same manner as Study 1a, yielding six trials in Study 1b. In these six trials, two faces were labeled as having depression ("This person has depression"), two as having migraines ("This person has migraines") and two as healthy ("This person is healthy"). Like Study 1a, participants viewed each face-diagnosis pair for four seconds. Because behavioral valence did not influence representations in Study 1a, behaviors were not paired with faces in Study 1b. For consistent timing across Studies 1a and 1b, however, participants viewed a blank screen for four seconds before being instructed to select the original face out of an array of 11 faces. Participants were randomly assigned to one of three task versions counterbalancing the three possible face-diagnosis pairings.

After the task, participants used 7-point scales (1 = not at all to 7 = completely) to rate stereotypes of both depressed and migraine-afflicted individuals as sad or threatening. These questions were presented in a random order.

RESULTS

Stereotype Endorsement

Sad. A one-sample *t*-test comparing sadness ratings (M = 5.64, SD = 1.42) to the scale midpoint verified that participants endorsed depressed people being stereotyped as sad, $t(184) = 15.74$, $p < .001$, $d = 1.15$, 95% CI [.97, 1.34]. Ratings for migraine-afflicted individuals fell below the midpoint ($M = 3.18$, $SD = 1.55$), $t(184) = 6.90$, $p < .001$, $d = .53$, 95% CI [.37, .68]. A paired *t*-test showed that depressed

individuals were endorsed as being stereotyped as sadder than migraine-afflicted individuals, $t(184) = 15.53$, $p < .001$, $d = 1.66$, 95% CI [1.39, 1.93].

Threatening. Ratings for depressed individuals ($M = 3.18$, $SD = 1.62$) fell below the scale midpoint, $t(184) = 6.90$, $p < .001$, $d = .51$, 95% CI [.35, .66], as did ratings for migraine-afflicted individuals ($M = 2.06$, $SD = 1.45$), $t(184) = 18.14$, $p < .001$, $d = 1.34$, 95% CI [1.13, 1.54]. However, depressed individuals were endorsed as being stereotyped as more threatening than migraine-afflicted individuals, $t(184) = 9.74$, $p < .001$, $d = .72$, 95% CI [.56, .89].

Perceptual Downgrading

Selected faces were coded as in Study 1a. We subjected scores to a repeated-measures ANOVA with Diagnosis (depression, migraines, healthy) as a factor (see Table 1b for descriptive statistics). A main effect of Diagnosis emerged, $F(2, 368) = 6.05$, $p = .003$, $\eta_p^2 = .03$, 95% CI [.0004, .07]. Participants represented faces labeled as depressed versus healthy to be sadder, $F(1, 184) = 6.60$, $p = .01$, $\eta_p^2 = .04$, 95% CI [.002, .10]. Participants also represented faces labeled as migraine-afflicted versus healthy to be sadder, $F(1, 184) = 10.49$, $p = .001$, $\eta_p^2 = .05$, 95% CI [.01, .13]. There was no difference in representations of faces labeled as depressed versus migraine-afflicted, $F(1, 184) = .75$, $p = .39$, $\eta_p^2 = .004$, 95% CI [0, .04]. All findings maintained direction and significance when including Participant Depression Diagnosis (150 participants had no prior diagnosis and 35 participant had a prior diagnosis) as a between-groups factor in the ANOVA. However, a main effect of Participant Depression Diagnosis emerged, $F(1, 183) = 4.29$, $p = .04$, $\eta_p^2 = .02$, 95% CI [0, .08]. Participants with a prior ($M = -7.57$, $SD = 9.75$) versus no prior ($M = -4.22$, $SD = 9.76$) diagnosis represented faces as sadder. Participant Depression Diagnosis did not interact with Diagnosis, $p = .34$.

DISCUSSION

Study 1b replicated Study 1a. Faces labeled as depressed versus as healthy were represented as sadder. Extending Study 1a, faces labeled as depressed *and* as migraine-afflicted were represented as sadder versus faces labeled as healthy. Importantly, faces labeled as depressed and as migraine-afflicted were represented as being similarly sad. This pattern occurred even though sadness was more strongly endorsed as a stereotype of depressed versus migraine-afflicted individuals. These data suggest that being labeled with a stigmatized condition might not specifically impact visual representations in a stereotype-consistent way. That is, if sadder visual representations were due to their being consistent with having a highly stigmatized condition, representations of depressed faces should have been sadder than migraine-afflicted faces. Instead, our findings suggest that the general negativity associated with having an illness might alter visual representations.

An important consideration for these findings is that people with migraines are stigmatized (Young, Park, & Kempner, 2013). However, migraines are likely a less

stigmatized condition than depression because the latter is perceived to be a less legitimate illness than the former (Lafrance, 2007). Moreover, sadness is positively associated with symptoms of migraines (Bostani et al., 2015). Sadness might thus be stereotypic of migraines to some extent. In turn, perceivers might assume that people with migraines are sad, affecting representations of their faces. An open question from Study 1b is thus if faces with arbitrary illness labels are broadly perceived in a negative way because illnesses are negative or if stronger stigma specifically triggers more broadly negative visual representations. Study 2 addressed these possibilities.

STUDY 2

Study 1b showed that labeling faces as depressed *or* as migraine-afflicted elicited sadder visual representations versus faces labeled as healthy. Study 2 tested if arbitrary illness labels broadly elicit a negativity bias in visual representations or if a negativity bias is specific to highly stigmatized illnesses. To address this possibility, we examined how arbitrary illness labels (i.e., depression and migraines) impacted the anger of visual representations. Like sadness, anger is a basic emotional expression (Ekman, 1992). However, we did not expect anger to be endorsed as a strongly stereotypic attribute of depression or migraines (measured by stereotype endorsement ratings). This expectation allowed us to characterize the negativity of visual representations given less stereotype consistency with arbitrary illness labels.

If illness labels elicit a negativity bias in visual representations, arbitrarily labeled depressed and migraine-afflicted faces should be similarly represented as angrier than faces labeled as healthy. However, if a broad negativity bias in visual representations is specific to strongly stigmatized conditions, arbitrarily labeled depressed faces should be represented as angrier than faces labeled as migraine-afflicted and as healthy. Whereas the former possibility would suggest a negativity bias in visual representations because illnesses are negative, the latter would suggest a broader negativity bias specific to highly stigmatized illnesses. Notably, these possibilities each suggest illness cues to have a strong impact on visual representations, contrasting the potentially lesser impact of illness-unrelated cues as assessed in Study 1a.

METHOD

Participants

Two hundred individuals recruited from Amazon Mechanical Turk provided informed consent and were compensated $.40. Eight participants were excluded for participating in Study 1a and three for participating in Study 1b. The final sample comprised 189 participants (M_{age} = 37.15 years, SD = 11.76 years, 18–73 years, 115 female).

Stimuli and Procedure

Study 2 replicated Study 1b with the following changes. The six faces were morphed with the face that had been manipulated to have a happy expression, but were also morphed with the same face now manipulated to have an angry expression. We generated the angry expression by changing FaceGen expression settings "anger" to 40%, "sneer" to 40%, "nostril dilator" to 50%, "lip pressor" to 40%, "lip tightener" to 30%, and "lips toward each other" to 50%.

After the perceptual downgrading task, participants used 7-point scales (1 = not at all to 7 = completely) to rate stereotypes of depressed and migraine-afflicted individuals as sad and angry. These questions were presented in a random order.

RESULTS

Stereotype Endorsement

Sad. A one-sample *t*-test comparing sadness ratings (M = 5.71, SD = 1.60) to the scale midpoint verified that participants endorsed depressed people being stereotyped as sad, $t(188) = 14.69$, $p < .001$, $d = 1.07$, 95% CI [.89, 1.25]. Ratings for migraine-afflicted individuals fell below the midpoint ($M = 3.39$, $SD = 1.64$), $t(188) = 5.11$, $p < .001$, $d = .37$, 95% CI [.22, .52]. Depressed individuals were stereotyped as sadder than migraine-afflicted individuals, $t(188) = 15.08$, $p < .001$, $d = 1.44$, 95% CI [1.20, 1.68].

Angry. Ratings for depressed individuals (M = 3.31, SD = 1.59) fell below the scale midpoint, $t(188) = 6.00$, $p < .001$, $d = .43$, 95% CI [.28, .58], as did ratings for migraine-afflicted individuals ($M = 2.06$, $SD = 1.45$), $t(188) = 6.59$, $p < .001$, $d = 1.34$, 95% CI [1.14 1.53]. Ratings of depressed and migraine-afflicted individuals did not differ, $t(188) = 1.21$, $p = .23$, $d = .09$, 95% CI [.06, .25].

Perceptual Downgrading

Selected faces were coded as in Studies 1a and 1b. Scores were entered into a repeated-measures ANOVA with Diagnosis (depression, migraines, healthy) as the independent variable (see Table 1c for descriptive statistics). A main effect of Diagnosis emerged, $F(2, 376) = 8.45$, $p < .001$, $\eta_p^2 = .04$, 95% CI [.01, .09]. Participants represented faces labeled as depressed versus as healthy to be angrier, $F(1, 188) = 16.61$, $p < .001$, $\eta_p^2 = .08$, 95% CI [.02, .16]. Participants also represented faces labeled as depressed versus as migraine-afflicted to be angrier, $F(1, 188) = 7.77$, $p = .006$, $\eta_p^2 = .04$, 95% CI [.003, .11]. There was no difference in representations of faces labeled as migraine-afflicted versus healthy, $F(1, 188) = 1.59$, $p = .21$, $\eta_p^2 = .008$, 95% CI [0, .05]. All findings maintained direction and significance when including Participant Depression Diagnosis (133 participants had no prior diagnosis and 56 participants had a prior diagnosis) as a between-groups factor in the ANOVA. Unlike Study 1b, there was no main effect of Participant Depression Diagnosis, $F(1, 187) = 2.34$, $p = .13$, $\eta_p^2 = .01$, 95% CI [0, .06]. Participant Depression Diagnosis did not interact with Diagnosis, $p = .19$.

DISCUSSION

In Study 2, faces labeled as depressed versus migraine-afflicted were visually represented as appearing angrier. This effect occurred even though anger was not endorsed as a strong stereotype of depression or migraines. Having depression versus migraines is considered to be more stigmatizing (Lafrance, 2007), an idea supported by Study 1b in that depressed individuals were endorsed as being more threatening than are migraine-afflicted individuals. Indeed, threat is a key component of stigma (Stangor & Crandall, 2000), is facilitated in perceptual processing (Schupp et al., 2004), and is associated with angry facial expressions (Hansen & Hansen, 1988). Angrier visual representations would thereby be expected of more threatening, and thus more highly stigmatized (here, depressed), faces. Study 2 thus suggests a broader negativity bias in representations to be specific to faces of individuals who are labeled as having a more highly stigmatized condition.

Together, the findings from Studies 1a, 1b, and 2 suggest that arbitrarily labeling individuals with a stigmatized condition (e.g., depression) negatively affects visual representations of the labeled faces. These findings further suggest that the underlying visual processing associated with these faces may also differ on the basis of stigma labels. Because the neural correlates of visual processing are well characterized, neuroimaging provides an ideal method to assess this possibility. If highly stigmatized conditions (e.g., depression) affect visual representations more than less stigmatized conditions (e.g., migraines), perceiving faces labeled with a stigmatizing condition should yield neural activity reflective of enhanced visual processing. Study 3 tested this possibility.

STUDY 3

Studies 1a, 1b, and 2 suggested that arbitrary labels implying that an individual has a highly stigmatizing condition elicit a negativity bias in visual representations. Across studies, being labeled as depressed yielded more negative representations than faces objectively appeared. Critically, Study 2 showed that being labeled as depressed versus migraine-afflicted yielded angrier visual representations, suggesting a stigma-specific negativity bias in visually representing faces. Study 3 extended these findings by testing if arbitrary stigma labels elicit more neural activity associated with visual processing. Such a pattern would conceptually replicate Studies 1a, 1b, and 2 by showing that arbitrary stigma labels modulate processing underlying visual perception.

If stigma elicits more negative visual representations of faces, we expected neural activity in visual processing regions to complement this effect by activating more toward more versus less stigmatized targets. Specifically, we predicted that perceivers would have broadly increased activation in regions key to visual processing, including extrastriate cortex (Haxby et al., 1991; Haxby, Hoffman, & Gobbini, 2000; Kanwisher, McDermott, & Chun, 1997), when perceiving depressed versus migraine-afflicted targets (Hypothesis 1). Notably, stigmatized individuals elicit

increased extrastriate activation consistent with enhanced visual processing (Cikara, Eberhardt, & Fiske, 2011; Krendl, Kensinger, & Ambady, 2012; Krendl, Macrae, Kelley, Fugelsang, & Heatherton, 2006; Krendl, Moran, & Ambady, 2012), although it remains unclear why that might be. For instance, images of stigmatized versus non-stigmatized targets could be more visually complex. If true, activation could reflect image complexity and not a stigma effect. If, as predicted, stigma affects visual processing, equivalent images differing only in if a label implies stigma should elicit dissociable engagement in visual processing regions.

Even though behavioral information did not qualify representations in Study 1a, Study 3 provided an opportunity to further explore effects of negative versus neutral behavioral information on visual processing. That is, do stigma-related cues impact visual representations (Studies 1a, 1b, and 2) and override any detectable effect of stigma-unrelated cues (Study 1a)? Critically, similar responses (as in Study 1a) do not necessitate equivalent underlying processes (as in Krendl, Moran et al., 2012). Because representations can negatively impact behavior toward targets (Krosch & Amodio, 2014), a better understanding of how people process stigma and paired valenced cues is important to inform future interventions designed to mitigate the consequences of being stigmatized. If stigma truly modulates visual processing irrespective of the valence of stigma-unrelated behavioral information, neural response in visual processing regions to depressed targets should be similar regardless of behavioral valence (Hypothesis 2a). However, valenced versus neutral information influences visual processing (Schupp, Markus, Weike, & Hamm, 2003) in visual areas (Lane, Chua, & Dolan, 1999) because it is more salient (Rozin & Royzman, 2001). Depressed faces paired with negative versus neutral behaviors could thus elicit such enhanced neural activity (Hypothesis 2b). Indeed, perceiving unconcealable stigma in negative social contexts elicits such enhanced activity in extrastriate cortex (Krendl, Moran et al., 2012).

One way to further explore how paired behavioral valence might affect neural responses to stigma is to identify neural regions co-active with brain regions associated with visual processing during person perception. For example, extrastriate cortex interacts with regions implicated in higher-level cognition when perceivers dissociate more (e.g., Black individuals) versus less stigmatized group members (Stolier & Freeman, 2016b). Identifying if such regions interact with other areas in response to evaluating faces arbitrarily labeled as depressed and that are paired with negative or neutral behaviors can elucidate mechanisms for how visual processing affects person perception. One possibility is that in the presence of neutral (i.e., non-diagnostic) behavioral information, perceivers may rely more on stereotypes when perceiving faces labeled as stigmatized. Orbitofrontal cortex (OFC) activation is involved in stereotype knowledge (e.g., Knutson, Mah, Manly, & Grafman, 2007) and in cognitive-perceptual interactions with extrastriate cortex (Bar, 2009) that may bias social category representations (Stolier & Freeman, 2016b). Thus, connectivity between visual processing regions and OFC may increase toward depressed faces paired with neutral versus negative information (Hypothesis 3). However, because valenced behavioral information affects activity in areas implicated in impression formation (e.g., dorsomedial prefrontal cortex; Mitchell,

Macrae, & Banaji, 2004), this connectivity may be reduced toward depressed faces paired with negative versus neutral behaviors. Connectivity analyses tested these possibilities on an exploratory basis.

METHOD

Participants

Thirty right-handed Indiana University students (M_{age} = 21.17 years; *SD* = 2.38 years; 18–29 years, 17 female) with no history of neurological problems and who were recruited through online advertisements participated and provided informed consent. This sample size was selected to ensure sufficient power for our analyses (Desmond & Glover, 2002; Thirion et al., 2007). The Indiana University Institutional Review Board approved this study.

Prior to being recruited, participants were screened to ensure they were right-handed (based on self-reports), not claustrophobic, were not pregnant, and did not have contra-indicators for safely participating (e.g., non-removable piercings). Participants were also screened to ensure that they had not previously, nor were they currently, suffering from depression. Regarding the former, participants indicated if they had ever been diagnosed with a mental disorder. To assess if they were currently experiencing depressive symptoms, participants completed the two-item Patient Health Questionnaire (PHQ), which has a sensitivity of 83% and specificity of 92% for diagnosing major depression (Kroenke, Spitzer, & Williams, 2003). Participants completed two testing sessions approximately one week apart. The first session consisted of a series of behavioral measures described below. The second session was the fMRI study.

Procedure

Approximately one week before the fMRI session, participants completed a two-hour behavioral testing session that included measures of their explicit and implicit bias (racial and mental illness), attitudes toward seeking mental health treatment, and an MRI safety screening. Details about these tasks are reported elsewhere (Cassidy & Krendl, 2016; Krendl & Cassidy, 2017).

Stimuli and Task. At the scanning session, participants completed two tasks related to mental health and an unrelated study. All three tasks were presented using E-prime 2.0 on a computer running Windows 7. The tasks all used event-related designs. The order of the mental health-related and unrelated tasks was counterbalanced. There were no order effects in any of the neuroimaging analyses described below. The same images were used for both mental health-related tasks (see below for details). Each image was presented once per task (i.e., twice over the two tasks). In the unrelated task, participants viewed 90 Black and 90 White faces. These faces were unique from the faces in the mental health-related tasks, and were not presented with any diagnostic information. The unrelated task consisted of two runs of three minutes each (for details, see Cassidy & Krendl, 2016).

The color images of Caucasian neutrally expressive faces (equal numbers of males and females) used in the mental health tasks were drawn from the PAL database (Minear & Park, 2004). Faces were equated for attractiveness, distinctiveness, and trustworthiness across conditions (for details, see Cassidy & Gutchess, 2012). The ages of the target individuals (for both males and females) ranged from college-aged to older adults.

In the first mental health-related task, participants viewed 120 faces, 40 each identified as being depressed, migraine-afflicted, or healthy (Krendl & Cassidy, 2017). Images were presented in pseudo-randomized order for 2 seconds each. On each trial, participants indicated how much they thought they would like the individual in the image (1 = not at all; 4 = very much). Participants could make ratings at any point during the 2-second window. Responses and reaction times (RTs) were recorded for each trial. The task consisted of one functional run of 169 time points that lasted 5 minutes and 46 seconds.

Like past tasks (Cloutier, Kelley, & Heatherton, 2011), the first mental health task conveyed diagnosis by placing a red, green, or yellow background behind each face. That is, diagnoses were not labeled with the words "depression," "migraines," or healthy." Color-diagnosis pairings were counterbalanced across task versions, as were faces and diagnosis. To ensure attention to the color-diagnosis pairings, participants reported at three separate time points (after instructions, the first scan, and immediately post-task) which diagnosis was paired with which color. All participants did this successfully at every assessment point, indicating that they knew the color-diagnosis pairings. No other information was provided about these images. Results from that task are reported elsewhere (Krendl & Cassidy, 2017).

The second mental health-related task was analyzed for the current manuscript and always followed the first. The same color-diagnosis pairings were used in the second mental health-related task as the first. Participants had all previously reported the color-diagnosis pairings with 100% accuracy and were told the color-diagnosis pairings in this second task were identical to those in the first task. Functional images were collected in two runs of 169 time points each that each lasted 5 minutes and 46 seconds. We used the same 120 faces as in the first task. Faces were presented in the same diagnosis condition as in the first task. Half of the faces were paired with negative behaviors (e.g., "This person litters"), whereas the other half was paired with neutral behaviors (e.g., "This person drives a red car"). Each face-diagnosis-behavior pairing was presented for 4 seconds. Negative and neutral behaviors were evenly distributed among diagnosis conditions (e.g., 20 depressed faces paired with negative behaviors and 20 depressed faces paired with neutral behaviors) and always placed directly below the face and colored background denoting diagnosis. Behaviors were selected from prior work (Somerville et al., 2006). Image order was randomized across the first and second tasks, meaning that images were not presented in the same order in the first and second tasks.

During the second mental health-related task, participants viewed each face-behavior pair for 4 seconds and indicated how much they liked each individual

using a 4-point scale (1 = highly dislike, 4 = highly like). Participants could make ratings at any point during the 4-second window. Participant responses and RTs were recorded. Images were presented in the center of the screen, and a behavior was presented directly below it. Images were randomly presented.

Baseline consisted of a central fixation cross, which was introduced as periods of jitter ranging from 2 to 8 seconds. The design of each version of the task was optimized using random-number generators to introduce jitter at pseudorandom intervals (which varied across task versions) on approximately 25% of the trials, with no more than two of the same diagnosis-behavior type appearing sequentially. The average ITI was 1038.96 ms.

There were six counterbalanced versions of the task. In three versions, a given image was paired with a specific negative behavior. The same image was paired with a specific neutral behavior in the other three versions. The versions were subdivided by the three diagnoses: depressed, migraines, or healthy. Thus, each image was viewed by 5 participants in one of six conditions: (1) depressed-negative, (2) depressed-neutral, (3) migraines-negative, (4) migraines-neutral, (5) healthy-negative, or (6) healthy-neutral. Responses were monitored to ensure attention.

fMRI Data Acquisition and Analysis

Data Acquisition. Whole-brain imaging was performed on a Siemens 3.0T TIM Trio MRI scanner using a 12-channel phase arrayed head coil at the Indiana University Imaging Research Facility in Bloomington, Indiana. Stimuli were presented using a back projector (Sony WUXGA VPL-FH30) and behavioral data were collected on a Dell laptop computer running Windows 7. The scanner was synced to the data collection equipment via scanner TTL.

Functional images were collected over two runs consisting of 169 time points each and using a fast field echo-planar sequence sensitive to blood oxygen level dependent contrast (T2*; 32 axial slices with manual AC-PC alignment, TE = 30 ms, TR = 2000 ms, flip angle = 70^0, 2.5 mm × 2.5 mm voxels, FOV = 240 mm, in-plane matrix size = 96 × 96, A/P phase encoding direction). Slices were 3.5 mm thick with no gap and collected in an ascending interleaved order. These slices provided partial-brain coverage (i.e., the entire cortex with at least partial cerebellum, but not brainstem). At the beginning of each functional run, the scanner acquired and discarded three dummy scans. We also included 8 seconds of fixation to the start of each run and 10 seconds of fixation at the end of each run (these fixations were not included in the above-reported overall percentage of fixation trials in each task).

At the end of each run, data were visually checked for excessive motion. If motion was detected during visual inspection, participants were reminded to remain still for the next run. Anatomical images were collected after all of the functional runs were completed, and were acquired with a high-resolution 3-D magnetization prepared rapid gradient echo sequence (sagittal rotation; 224 slices, TE = 3.02 ms, TR = 2020 ms, TI = 1020 ms, flip angle = 9^0, .8 × .8 mm voxels; with fat suppression) lasting approximately 5 minutes.

Data Preprocessing. Preprocessing and analyses of functional data were conducted in SPM8 (Wellcome Trust Centre for Neuroimaging, London, U.K.). Images

were realigned to correct for motion, normalized to the MNI (Montreal Neurological Institute) template, and smoothed using a 6-mm FWHM isotropic Gaussian kernel. Data were resampled to 3 mm-isotropic voxels. A general linear model with the three diagnoses (depression, migraines, and healthy), the two behavioral valences (negative, neutral), and covariates of no interest (a session mean, a linear trend, and six movement parameters derived from realignment corrections) computed parameter estimates (β) and t-contrast images (containing weighted parameter estimates) for each comparison at each voxel and for each participant.

Whole-Brain Analyses. We examined how diagnosis and behavioral valence affected neural activity in a 3 (Diagnosis: depression, migraines, healthy) × 2 (Behavioral Valence: negative, neutral) whole-brain ANOVA. Of interest was to determine if participants had increased activation in brain regions implicated in visual processing toward individuals identified as suffering from depression versus those experiencing migraines (the non-stigmatized illness control) or those identified as healthy.

The whole-brain ANOVA was conducted using an alpha level of $p < .05$ corrected for multiple comparisons (controlling family-wise error rate; FWE-correction). Main effects and interactions from the whole-brain ANOVA were characterized through region of interest (ROI) analyses using Marsbar (http://marsbar.sourceforge.net/). This approach simply characterizes the nature of emergent interactions in brain activation (e.g., Poldrack, 2007). Each ROI consisted of an 8 mm sphere surrounding a peak coordinate. Average parameter estimates from each ROI were extracted by using the contrast from each condition against baseline.

Functional Connectivity. Exploratory functional connectivity analyses were conducted using the Generalized Psychophysiological Interactions (gPPI: http://brainmap.wisc.edu/PPI; McLaren, Ries, Xu, & Johnson, 2012) Toolbox in SPM8. gPPI accommodates multiple task conditions in the same PPI model and compares functional connectivity with a single seed region across conditions. Each seed region was used to create volumes of interest (VOIs) for each subject by creating a 6 mm sphere around a peak coordinate. Within each subject, the gPPI toolbox estimated functional connectivity across the entire brain with the seed in the two behavioral valence conditions (negative and neutral) for the relevant diagnoses. Because we were primarily interested in connectivity between visual areas and OFC when perceivers evaluated depressed individuals paired with neutral versus negative behaviors, we first entered the individual-subject gPPI contrasts of [Depressed-Neutral > Depressed-Negative] into a single-sample *t*-test. This analysis identified regions with activity that positively correlated with extrastriate activity when behaviors were neutral versus negative. We conducted three additional single-sample *t*-tests on the three other individual-subject contrasts of lesser interest ([Depressed-Negative > Depressed-Neutral], [Healthy-Neutral > Healthy-Negative], [Healthy-Negative > Healthy-Neutral]) to provide a more comprehensive account of connectivity from extrastriate cortex during the task and because we unexpectedly found opposite activations for depressed and healthy faces as a function of Behavioral Valence (see fMRI Results).

Given the exploratory nature of the connectivity analyses, we set an a priori cluster threshold of 15 contiguous voxels at $p < .005$. Simulations have shown that this threshold provides a desirable balance between Type I and Type II error

TABLE 2. Mean (standard deviation) Likability Ratings (A) and Response Times (RTs; B) from Study 3

A. Likability ratings	Negative	Neutral
Depression	1.58 (.22)	2.90 (.49)
Migraines	1.61 (.27)	3.00 (.44)
Healthy	1.61 (.28)	3.00 (.44)
B. RTs (ms)	**Negative**	**Neutral**
Depression	1953.64 (264.74)	2034.76 (319.93)
Migraines	1931.43 (317.86)	2054.24 (310.13)
Healthy	1981.73 (301.73)	2019.32 (340.65)

Note. Ratings range from 1 (not at all likable) to 4 (highly likable).

rates in neuroimaging research (Lieberman & Cunningham, 2009). Notably, this threshold is consistent with the threshold used in one of the few studies of impression formation and stigma (Stanley et al., 2012). However, it is important to note that these analyses have a less stringent threshold than our whole-brain ANOVA, and should be interpreted as preliminary evidence that may inform future related work.

RESULTS

Likability Ratings and RTs

We first examined if ratings varied by Diagnosis or Behavioral Valence. Data from two participants were excluded because they did not respond to over 30% of trials (41 and 48 trials, respectively). The remaining participants' ratings were entered into a 3 (Diagnosis: depressed, migraines, healthy) × 2 (Behavioral Valence: negative, neutral) repeated-measures ANOVA (see Table 2a for descriptive statistics). A main effect of Behavioral Valence emerged, $F(1, 27) = 265.29$, $p < .001$, $\eta_p^2 = .91$, 95% CI [.82, .94]. Faces were less likable when paired with negative versus with neutral behaviors. There was no effect of Diagnosis, $F(2, 54) = 1.20$, $p = .31$, $\eta_p^2 = .04$, 95% CI [.00, .16] and no interaction, $F(2, 54) = .80$, $p = .46$, $\eta_p^2 = .03$, 95% CI [.00, .13].

RTs were entered into a 3 (Diagnosis: depressed, migraines, healthy) × 2 (Behavioral Valence: negative or neutral) repeated-measures ANOVA (see Table 2b for descriptive statistics). A main effect of Behavioral Valence emerged, $F(1, 27) = 6.14$, $p = .02$, $\eta_p^2 = .19$, 95% CI [.003, .41]. Participants had faster RTs for faces paired with negative versus neutral behaviors. There was no effect of Diagnosis, $F(2, 54) = .19$, $p = .83$, $\eta_p^2 = .007$, 95% CI [.00, .07], and no interaction, $F(2, 54) = 1.33$, $p = .27$, $\eta_p^2 = .05$, 95% CI [.00, .17].

Hypothesis 1: Activation in Visual Processing Areas Will Dissociate Stigmatized From Non-Stigmatized Targets

One participant was excluded for excessive movement during the task (> 2 mm over one functional run). The data of the remaining 29 participants were entered

into a 3 (Diagnosis: depressed, migraines, healthy) × 2 (Behavioral Valence: negative or neutral) whole-brain ANOVA (at FWE-corrected $p < .05$; see Table 3 for all activations).

A main effect of Diagnosis emerged in a large swath of the occipital regions associated with visual processing that peaked in right striate cortex (i.e., calcarine sulcus—BA 17) and that included sub-peaks extending into a large swath of extrastriate cortex (e.g., right inferior occipital and fusiform gyri—BAs 18/19) associated with face processing. Because this activation spanned such a large area of occipital cortex using a conservative threshold, we interpreted the findings in terms of broadly construed visual processing. Suggesting that arbitrary stigma labels elicit differential visual processing, ROI analyses (see fMRI methods) on the peak (12, -93, 0) revealed more activity toward depressed versus migraine-afflicted targets, $t(28) = 7.75$, $p < .001$, $d = 1.63$, 95% CI [1.04, 2.22]. Curiously, increased activation emerged for healthy versus depressed, $t(28) = 2.60$, $p = .02$, $d = .30$, 95% CI [.06, .54], and migraine-afflicted, $t(28) = 10.64$, $p < .001$, $d = 2.15$, 95% CI [1.46, 2.83], targets.

Support for Hypothesis 2b: Activation in Visual Processing Areas Will Increase Toward Depressed Faces Paired With Negative Versus Neutral Behaviors

Consistent with Hypothesis 2b, a Diagnosis × Behavioral Valence interaction yielded activation consistent with visual processing in right inferior occipital gyrus and right cuneus. To characterize these interactions, ROI analyses (Figure 2b) on the peak activation yielded more activation for depressed targets paired with negative versus neutral behaviors, $t(28) = 6.80$, $p < .001$, $d = 1.15$, 95% CI [.70, 1.60], suggesting that the valence of behaviors unrelated to stigma may qualify the visual processing of stigmatized targets. A nonsignificant pattern emerged for migraine-afflicted targets, $t(28) = 1.79$, $p = .08$, $d = .39$, 95% CI [.05, .83]. More activation emerged toward healthy targets paired with neutral versus negative behaviors, $t(28) = 5.35$, $p < .001$, $d = .90$, 95% CI [.49, 1.30].

Hypothesis 3: Activation in Visual Processing Areas Will Have Increased Orbitofrontal Connectivity for Depressed Individuals Paired With Neutral Versus Negative Behaviors

Because striate and extrastriate activation increased toward depressed targets paired with negative versus neutral behaviors, differential connectivity by behavioral valence can inform the processes underlying how stigma impacts visual processing. For instance, in the absence of diagnostic behavioral information (e.g., a neutral versus a valenced behavior), connectivity with OFC may increase given the roles of OFC and visual areas in representing and integrating stereotypic associations (Stolier & Freeman, 2016b).

We conducted exploratory functional connectivity analyses using a right occipital seed (MNI coordinates: 12, -93, 0) defined from the whole-brain Diagnosis × Behavioral Valence interaction. Although [Depressed-Neutral > Depressed-Negative] was of interest, we analyzed [Depressed-Negative > Depressed-Neutral],

TABLE 3. Results from the 3 (Diagnosis: Depression, Migraines, Healthy) × 2 (Behavioral Valence: Negative or Neutral) Whole-Brain Voxel-Wise ANOVA in Study 3. Corrected $p < .05$ (FWE-correction) with MNI Coordinates of Peak Activations

Region	BA	x	y	z	k-extent	F
Diagnosis main effect						
L cerebellum		-39	-48	-24	9	19.76
R inferior occipital gyrus (extrastriate)	19	42	-72	-9	1	16.03
R inferior occipital gyrus (extrastriate)	18	48	-78	0	1	15.78
R calcarine sulcus (striate)	17	12	-93	0	1081	51.57
L calcarine sulcus (striate)	17	-9	-93	-9	*	49.15
L middle occipital gyrus (extrastriate)	18	-21	-99	0	*	41.82
Behavioral Valence main effect						
No significant voxels						
Diagnosis × Behavioral Valence interaction						
L cerebellum		-42	-78	-15	10	19.45
R cerebellum		27	-78	-15	1	16.29
L inferior occipital gyrus (extrastriate)	17	-18	-90	-9	3	16.13
R calcarine sulcus (striate)	17	21	-93	3	14	20.47
R calcarine sulcus (striate)	17	12	-93	0	*	17.42
L middle occipital gyrus (extrastriate)	18	-21	-96	0	1	17.49
R cuneus (extrastriate)	12	18	-99	12	1	16.95

Note. Organized from anterior to posterior regions; *sub-cluster of above-listed region.

[Healthy-Neutral > Healthy-Negative], and [Healthy-Negative > Healthy-Neutral] because we unexpectedly found opposite activations for depressed and healthy faces as a function of Behavioral Valence. These analyses (see Table 4 for all activations) provide an inclusive account of connectivity with visual processing areas that may be informative for future work.

Supporting Hypothesis 3, increased connectivity between visual cortex and OFC emerged for depressed targets paired with neutral versus negative behaviors (a). Interestingly, increased connectivity with right dorsomedial prefrontal cortex (dmPFC; BA 10) emerged for depressed targets paired with negative versus neutral behaviors (Figure 3b). Connectivity did not differ by behavioral valence with OFC or dmPFC for healthy targets.

DISCUSSION

Study 3 conceptually replicated Studies 1a, 1b, and 2 using a different level of analysis. As expected, increased extrastriate activation (spanning inferior occipital and fusiform gyri, regions associated with face processing; see a) emerged toward depressed versus migraine-afflicted targets. Extending these studies, Study 3 provides the first evidence that arbitrarily labeling targets as stigmatized also modulates the visual processing of target faces.

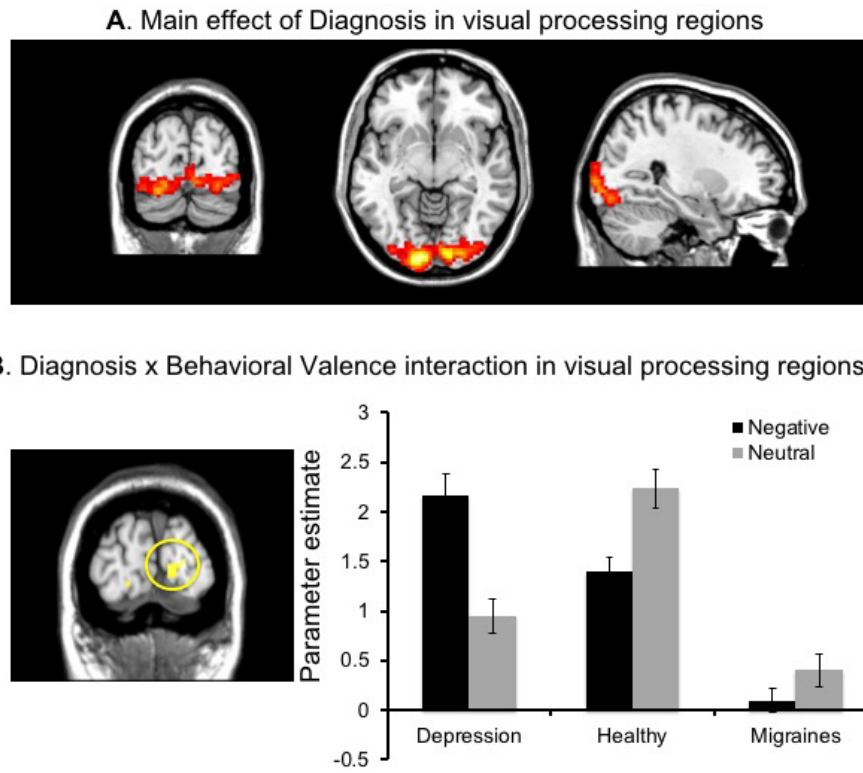

FIGURE 2. A main effect of Diagnosis from the whole-brain 3 (Diagnosis: depression, migraines, healthy) × 2 (Behavioral Valence: negative or neutral) voxel-wise ANOVA in Study 3 emerged broadly across brain regions implicated in visual processing ($p < .05$, FWE-corrected), shown here at 27, -84, 7 (A). A Diagnosis × Behavioral Valence interaction also emerged in visual cortex ($p < .05$, FWE-corrected), shown here at 12, -93, 0, and with parameter estimates characterizing the interaction at this coordinate and with error bars reflecting SEM (B).

Although extrastriate regions were responsive to stigma as expected, consistent with past work (e.g., Krendl, Moran et al., 2012), striate cortex (e.g., calcarine sulcus; BA 17) also activated more toward depressed versus migraine-afflicted targets. Extrastriate regions are central to the interpretation of images (e.g., processing faces; Kanwisher et al., 1997). By contrast, striate activity reflects initial processing of images propagated to specialized extrastriate areas (Hubel & Wiesel, 1977). Interestingly, striate activation after initial processing may reflect perceiver awareness of (Pascual-Leone & Walsh, 2001) and attention to (Roelfsema, Lamme, & Spekreijse, 1998) targets. Stigmatized individuals may yield increased attention because stigma is associated with greater threat (Stangor & Crandall, 2000). Future work with greater temporal precision (e.g., ERP) can investigate this possibility. Regardless, robust and widespread activation across striate and extrastriate areas suggest the broad modulation of visual processing as a function of arbitrary stigma labels.

Study 1a showed that stigma labels yielded negative visual representations irrespective of behavioral information. Potentially qualifying these findings, Study

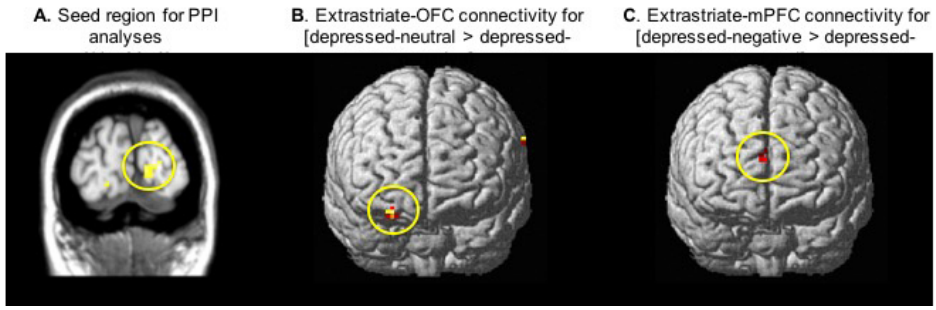

FIGURE 3. The results of the gPPI analyses from a seed region at 12, -93, 0 (A) yielded functional connectivity with OFC (BA 11) for [depressed-neutral > depressed-negative] (B) and with dmPFC (BA 10) for [depressed-negative > depressed-neutral] (C).

3 found more striate and extrastriate activation toward depressed targets paired with negative versus neutral behaviors. This finding is consistent with work showing that equivalent responses do not necessitate equivalent neural mechanisms to reach them (as in Krendl, Moran et al., 2012). Valenced information increases extrastriate activity (Lane et al., 1999). One plausible explanation for this finding is that the combination of stigma and negative (versus neutral) behaviors may have been particularly salient to perceivers, yielding increased neural response. Speculatively, this salience might yield increased attention to these targets that is reflected in enhanced visual processing.

Exploratory connectivity analyses elaborated on how valenced behavioral cues affect the visual processing of stigmatized targets. We predicted that without diagnostic behavioral cues (i.e., neutral versus negative behaviors), person perception may be shaped by prior knowledge through the interplay of activity in visual processing areas and OFC (Stolier & Freeman, 2016b). Supporting this idea, such connectivity emerged toward depressed targets paired with neutral versus negative behaviors. By contrast, increased connectivity with dmPFC emerged for depressed targets paired with negative versus neutral behaviors. DMPFC plays a causal role in updating impressions from appearances and behavioral information (Ferrari et al., 2016). Thus, one possibility is that combining stigma cues with negative behaviors engaged impression updating (Baron, Gobbini, Engell, & Todorov, 2011). Although representations may ultimately be negative (Study 1a), these findings suggest that valenced cues may still shift how activity in visual processing areas contributes to the processing of stigmatized faces. Because these analyses were exploratory, these findings should be cautiously interpreted. It will be important for future work to investigate the interplay between stereotype- and impression-related processes with visual processing to better detail how people process and represent stigma.

Two unexpected findings from Study 3 were that healthy versus depressed targets elicited increased extrastriate response and that healthy targets elicited more extrastriate response given neutral versus negative behaviors. Albeit speculative, one explanation for these findings is that, broadly, healthy targets (particularly those paired with neutral versus negative behaviors) may have been more self-

TABLE 4. Results from Exploratory Functional Connectivity Analyses Using a Seed in Right Occipital Cortex (12, -93, 0) for Depressed and Healthy Faces as a Function of Behavioral Valence in Study 3 (all coordinates MNI)

Region	BA	x	y	z	k-extent	t
Depressed-Neutral > Depressed-Negative						
R orbitofrontal cortex	11	24	48	-18	19	4.49
R precentral gyrus	4/6	36	-9	39	32	4.47
L inferior parietal lobule	40	-69	-24	33	23	4.80
R insula	13	36	-27	24	23	4.42
L paracentral lobule	5	-6	-39	57	18	4.62
R inferior parietal lobule	40	48	-45	24	23	3.92
R precuneus	7	30	-45	51	16	3.43
Depressed-Negative > Depressed-Neutral						
R dorsomedial prefrontal cortex	10	3	66	21	15	4.09
L fusiform gyrus	18	-18	-93	-15	35	4.38
R inferior occipital gyrus	17/18	12	-96	-9	99	4.64
R fusiform gyrus	18	21	-96	-18	*	3.76
L cerebellum		-36	-78	-18	19	3.39
Healthy-Neutral > Healthy-Negative						
L cerebellum		-36	-75	-33	19	3.65
Healthy-Negative > Healthy-Neutral						
R inferior frontal gyrus	9/47	42	12	18	15	3.72
R subcallosal gyrus	34	18	6	-12	20	4.48
R uncus	38	18	3	-33	25	4.88
R insula	13	39	3	-3	31	3.75
R middle temporal gyrus	21	51	-9	-12	44	5.48
L inferior temporal gyrus	20	-33	-9	-45	26	3.52
R inferior temporal gyrus	20	48	-9	-39	36	4.06
R middle temporal gyrus	39	57	-54	15	19	4.12

Note. Organized from anterior to posterior regions; *sub-cluster of above-listed region.

relevant to the non-depressed perceivers than the other two diagnosis conditions. Indeed, self-relevance yields increased extrastriate activity (e.g., Macrae, Moran, Heatherton, Banfield, & Kelley, 2004; Uddin, Kaplan, Molnar-Szakacs, Zaidel, & Iacoboni, 2005), although the reason for this has been largely unexplored. This task may have captured nuances in visual response. First, whereas the increased stigma of depression versus migraines may have yielded enhanced response, the self-relevance of being healthy versus depressed or migraine-afflicted may have also yielded enhanced activity. Second, the salience of information paired with targets may elicit additive effects in activity based on the relevance of the pairing and that are not reserved for stigmatized targets. Future work should examine these possibilities.

GENERAL DISCUSSION

Across four studies and two levels of analysis, arbitrarily labeling people as having a highly stigmatized condition negatively affected visual representations of faces (appearing sadder in Studies 1a–b and angrier in Study 2) and modulated neural responses associated with visual processing (e.g., fusiform gyrus; Study 3). For instance, Study 2 showed that faces arbitrarily labeled as depressed elicited angrier visual representations than faces labeled as migraine-afflicted or healthy. These angrier representations emerged even though anger was not endorsed to be stereotypic of depression, suggesting a stigma-specific negativity bias versus a stereotype-consistent bias. Supporting this idea, visual representations (Study 2) and processing (Study 3) were most strongly influenced by arbitrary illness labels reflecting highly (depression) versus less (migraines) stigmatized conditions. Together, these studies extended past work on unconcealable stigmas (Caruso et al., 2009; Dotsch et al., 2008) by showing that stigma-related cues need not even be characteristics of faces themselves to influence how faces are processed and represented.

Both depression and migraines are stigmatized illnesses. However, depression is more highly stigmatized than migraines because it is considered to be a less legitimate illness (Lafrance, 2007). Here, depression elicited more broadly negative visual representations and enhanced visual processing versus migraines. Broad shifts in visual representations and processing may thus be specific to highly stigmatizing conditions. What might underlie these shifts? One possibility is that enhanced attention toward people with highly stigmatized conditions, given that they are perceived as more threatening than less stigmatized faces (Study 1b) could yield increased visual processing (e.g., Roelfsema et al., 1998). Alternatively, beliefs about highly stigmatized illnesses could modulate visual representations and related processing (Krendl & Cassidy, 2017). It will be important for future work to characterize why only highly stigmatized conditions are associated with broad shifts in visual processing.

Although Study 1a suggested that stigma-related cues (e.g., an illness label) elicit negative representations irrespective of the valence of paired stigma-unrelated behaviors, Study 3 identified distinct neural correlates potentially disentangling how paired stigma-unrelated behaviors combine with arbitrarily labeled stigma to affect visual processing. Specifically, exploratory analyses suggested how visual and cognitive processing might interact when perceiving targets arbitrarily labeled as having stigma (Study 3). Specifically, cognitive processing might interface with visual processing in distinct ways depending on the valence of paired behaviors and a stigmatized target. When perceiving stigmatized targets with neutral (e.g., non-diagnostic) information, prior group knowledge may interface with visual processing to shift how a target is represented. When perceiving negatively portrayed stigmatized targets, however, impression-related processes may interface with visual processing to shift representations. These potentially distinct processes

interfacing with visual processing may yield the same behavior: more negative visual representations. Supporting this possibility, past work linking behavior and neural response to stigma has found that distinct neural processes underlie similar patterns of behavioral results (e.g., Krendl, Moran et al., 2012). Indeed, Study 1a showed sadder representations of ostensibly depressed faces irrespective of behavioral valence. These findings highlight one benefit of a multi-level approach in understanding person perception.

There are several limitations to the present work that may affect how these findings can be interpreted. In Studies 1a, 1b, and 2, participants selected a face that best resembled a target from an array four seconds after initially perceiving the target face. Selected faces could thus potentially represent how depressed individuals are expected to look versus actual negative representations. However, prior work has shown that perceptual downgrading effects emerge even when participants *match* a face from an array to a visible referent (Cole et al., 2016). In Studies 1a, 1b, and 2, participants were instructed that they would match an original target face to a face from an array within seconds of seeing the original face. Thus, it is unlikely that participants chose a more negative (i.e., angrier) face because they could not remember what the target looked like. Indeed, on average, participants selected the true target face if it was given a non-stigmatizing label (i.e., being healthy).

One limitation of Study 3 was that participants completed a mental health-related task with the same face-diagnosis pairings prior to the described task. Across both tasks, participants rated target likability. Although behaviors were not introduced until the second task, exposure to and ratings of the targets may have affected their ratings in the second task. To test this possibility, we compared liking ratings across the two tasks, but only for targets paired with neutral behaviors (liking systematically decreased for faces paired with negative behaviors). Overall, participants liked targets (paired with neutral behaviors) in the second task more than they had liked the same targets (without behaviors) in the first task. This increase was highest for migraine-afflicted targets, but did not systematically differ for the faces that were paired with healthy and depression diagnoses. One possibility as to why liking might have increased between the two tasks is that participants were familiar with the images on the second task (because they had seen them on the first). Indeed, much prior work has shown that mere exposure to in-group and out-group members increases liking (Zebrowitz, White, & Wieneke, 2008).

Although much cognitive (for a review, see O'Callaghan et al., 2017) and recent social (for reviews, see Albohn & Adams, 2016; Stolier & Freeman, 2015) research suggests that visual and cognitive regions interact during person perception, this interaction remains a debated topic (Firestone & Sholl, 2016). Our findings contribute to this discussion by demonstrating across two levels of analysis suggest that stigma might indeed affect visual processing. However, it will be imperative that future work use different methodologies to conceptually replicate the present findings to further support stigma effects on visual processing.

Together, this work shows that stigma labels (irrespective of their veracity) have a profound affect on person perception by changing the visual processing and representation of faces. These findings have important implications for work attempting to reduce the negative consequences of social stigma. Because cognitive processes may influence person perception, understanding how visual processing is shaped by prior knowledge will be important for developing interventions that are effective in reducing stigmatization.

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