

Misclassification and identification of emotional facial expressions in depressed youth: A preliminary study

Abstract

Objective: Accurate processing of social and affective cues, especially facial cues, is important for human adaptation. Previous studies have examined depressed adults' sensitivity to identify emotional facial expressions, yet only one study has investigated this in depressed youth. Additionally, very little is known about whether depressed individuals exhibit biases when incorrectly labeling, or misclassifying, emotional expressions. Therefore, this preliminary study explored whether sensitivity to, or misclassification of, emotional facial expressions differed among currently depressed youth, those with a history of depression, and never-depressed control participants. Method: A community sample of 280 youth (7 to 16 years; $M = 11.51$, $SD = 2.44$; 56% girls) completed a forced-choice emotion identification task consisting of a series of randomly presented facial images that morphed an emotional expression (angry, happy, and sad) with a neutral expression in 10% increments (e.g. 10% sad/90% neutral; 20% sad/80% neutral). Results: Findings demonstrated that currently depressed youth differed from remitted and never-depressed youth in their sensitivity to identify all emotional expressions. Additionally, currently depressed youth were more likely than remitted and never-depressed youth to misclassify happy and sad facial expressions as angry. Conclusions: Results suggest that currently depressed youth exhibit reduced sensitivity to identify facial expressions of emotion and show biased perceptions of threat, which may contribute to the maintenance of their depressive symptoms.

Keywords: depression, youth, emotion identification, emotion misclassification

Misclassification and identification of emotional facial expressions in depressed youth: A preliminary study

Approximately 8 to 16% of adolescents experience an episode of depression each year (Avenevoli, Knight, Kessler, & Merikangas, 2008), and research has shown adolescent-onset depression to substantially increase the risk for recurrence of depression in adulthood (Rutter, Moffitt, & Caspi, 2006). Additionally, clinically significant rates of depression are seen in children as young as age 8, with depressive symptoms and episodes increasing considerably in both boys and girls from childhood into adolescence (Avenevoli et al., 2008). Therefore, understanding factors that contribute to the development and maintenance of depression in youth is of particular importance.

Interpersonal dysfunction (e.g., interpersonal conflict or negative cognitions surrounding interpersonal interactions) contributes to both the development and maintenance of depression (Rudolph, 2009). Biased processing of socially imbued affective cues, such as emotional facial expressions, may underlie such interpersonal difficulties and contribute to the development, maintenance, and recurrence of depression. Specifically, currently depressed adults demonstrate attention and memory biases for negative material (Mathews & MacLeod, 2005). Negative biases in identification of, and attention to, emotional expressions may lead to detrimental interpersonal interactions (Carton, Kessler, & Pape, 1999), which are likely to contribute to the maintenance of depressive symptoms (Geerts & Bouhuys, 1998).

Many studies with adults have examined the link between the ability to identify emotional expressions and depression (e.g., Carton et al., 1999; Joormann & Gotlib, 2006). Results from these studies have yielded mixed findings. Whereas some show a general deficit in emotion identification (Carton et al., 1999), others demonstrate deficits in labeling specific

emotions, such as sadness and happiness (Joormann & Gotlib, 2006). A recent meta-analysis examining the extant literature found depressed adults exhibited a general impairment in emotion identification (Demenescu, Kortekaas, den Boer, & Aleman, 2010). A limitation of previous studies, however, is that the majority utilized prototypical (i.e., full intensity) emotional facial expressions, which lack ecological validity as individuals most typically encounter subtle emotional expressions in everyday social interactions.

More recently, researchers have begun to use facial stimuli that represent various degrees of emotional intensity (faces morphed gradually from neutral to full intensity emotion) to examine the relation between depression and how sensitively one can detect specific emotions (i.e., what is the lowest threshold necessary for identifying an emotion). For example, in two studies (Joormann & Gotlib, 2006; LeMoult, Joormann, Sherdell, Wright, & Gotlib, 2009) adult participants viewed an emotional face as it slowly morphed from 0 to 100% of the target emotion (angry, happy, or sad) and were asked to stop the task at the lowest intensity necessary for them to identify the emotion. Results from studies using this task indicated that currently depressed adults and remitted adults with a history of recurrent depression were less sensitive in identifying happy expressions (i.e., needed greater emotional intensity before stopping the task and correctly identifying happy expressions) compared to never-depressed adults (Joormann & Gotlib, 2006; LeMoult et al., 2009). Although clearly informative for investigating the amount of emotional intensity required for accurately identifying emotional faces, this type of task precludes examination of whether participants exhibit biases across the full range of emotional intensity. That is, because responses were limited to that point along the morph continuum when participants first recognize the target emotion, it is unclear whether biases exist only at that point or are more generally evident across a broader range of emotional intensity.

Additionally, almost no research has examined whether depressed individuals of any age demonstrate systematic biases in the type of errors made when incorrectly labeling, or misclassifying, emotional expressions (i.e., labeling a happy face as sad). Given the previously noted deficits in how sensitively emotion is identified among depressed adults, investigating whether there are systematic misclassification biases could provide a critical next step in understanding the emotion processing difficulties experienced by depressed individuals. However, no adult research has examined systematic biases in misclassification, and only one study among youth has examined biases in both the sensitivity to identify and tendency to misclassify emotional expressions. Utilizing a clinic-referred sample (ages 8 to 18) of depressed youth, youth with comorbid depression and conduct disorder, and healthy controls, Schepman and colleagues (2012) found that depressed youth more often perceived low-intensity emotional faces of any emotion as sad. Although these results are intriguing, it is still unknown whether currently asymptomatic youth with a history of depression demonstrate similar patterns of emotion identification biases as those who are currently depressed. Understanding whether or not these biases exist as a latent risk factor among youth is a notable gap in the literature and could provide valuable information for the creation of depression treatment or prevention protocols that aim to improve emotion identification.

Although there is little research among depressed youth to inform us what specific biases to expect when examining youths' sensitivity to detect and misclassify emotional expressions, general information processing research (e.g., attention to emotion) and research among at-risk youth (daughters of depressed mothers) suggests that depressed individuals demonstrate biased processing of negative emotions, such as sadness and anger. For example, depressed youth experience increased amygdala response when attending to threat (Beesdo et al., 2009), and

youth at-risk for depression require more emotional intensity to identify sad faces and make more errors when identifying angry faces (Joormann, Gilbert, & Gotlib, 2010). Further investigation into whether depressed youth and youth with a history of remitted depression demonstrate biases when identifying and misclassifying emotional expressions may provide a greater understanding of the social difficulties that are commonly experienced by depressed youth (e.g., Rudolph, 2009).

Given the significant lack of research in youth populations, the primary goal of this study was to provide a preliminary investigation of depression-related biases in the identification of emotional facial expressions among youth. Specifically, we compared currently depressed, youth with a history of depression (i.e., remitted depressed), and never-depressed youth in their sensitivity to identify emotional expressions (angry, happy, and sad) and potential systematic biases in the misclassification of emotional expressions. Given previous mixed findings in currently depressed adults, we examined whether depressed youth would demonstrate biased sensitivity to identify emotional expressions, and, if so, whether these biases would reflect a general or specific deficit in their sensitivity to identify emotion. Second, we explored whether currently depressed youth would demonstrate biased processing of negative emotions (i.e., sadness and anger) when misclassifying emotional expressions, as compared to remitted depressed and never-depressed youth. We hypothesized that depressed youth would misclassify emotional faces more frequently as sad and angry. Last, we examined whether remitted depressed youth would exhibit similar biases as currently depressed youth in identification and misclassification of emotional expressions. Findings in the adult literature suggest remitted adults with a history of recurrent depression show similar biases in emotion identification as currently depressed adults (Joormann & Gotlib, 2006; LeMoult et al., 2009); therefore, we

expected that currently depressed and remitted depressed youth would exhibit similar identification and misclassification biases.

Methods

Participants

Brief informational letters were mailed to families in participating school districts in suburban New Jersey. Approximately 725 families contacted the laboratory for more information, and 407 (56%) agreed to participate in the study with 280 youth having complete data for the purposes of the current study. The study's 56% participation rate is comparable to that found in previous community-based, general samples examining youth depression (e.g., 61% in Lewinsohn, Hops, Roberts, Seeley, & Andrews, 1993). Youth were in 3rd, 6th, or 9th grade (ages ranged from 7 to 16 years; $M = 11.51$, $SD = 2.44$). The present sample was representative of both the broader population of the geographical area and school districts from which the sample was drawn, including ethnicity and race (see Table 1). Youth were excluded if they had a learning disability, severe psychiatric diagnosis (e.g., autism, psychosis), or were not fluent in English, which were factors likely to interfere with completion of an extensive laboratory protocol.

Materials

Diagnostic Status. Trained interviewers administered the Mood Disorders subsections of the well-validated Schedule for Affective Disorders and Schizophrenia for School Age Children (K-SADS-PL; Kaufman, Birmaher, Brent, & Rao, 1997) to youth and parents about their child to assess for current and past episodes of depression and mania. No youth was diagnosed with a bipolar spectrum disorder. Interviewers then utilized both youth report and parent report about youth to determine youth diagnostic status using best estimate diagnostic procedures.

Interviewers were supervised by Ph.D. level graduate students, and regular reliability meetings took place which showed 85% agreement among all trained interviewers. Youth participants were included in the currently depressed group ($n= 12$) if they met DSM-IV criteria for clinical depression (i.e., Major Depressive Disorder, Minor Depressive Disorder, and Dysthymia) at the time of the diagnostic interview. Participants were included in the remitted depressed group ($n= 68$) if they had a history of clinical depression but were not currently depressed. Youth with a history of remitted depression had been symptom free for at least 9 weeks ($M= 124.42$ weeks, $SD= 107.71$). Finally, the never-depressed group ($n= 200$) consisted of youth with neither a current nor past depressive episode. The rates of current and past depression found in the sample are similar to those found in other studies utilizing community samples of youth (e.g., Avenevoli et al., 2008; Lewinsohn et al., 1993).

Morphed faces task.

Stimuli. Facial expressions were taken from a standardized stimulus set (Matsumoto & Ekman, 1988). Stimuli for the morphing task were created by morphing emotional (i.e., angry, happy, and sad) and neutral faces from each actor to form a continuum of 10% increments, resulting in nine morphed images for each actor (e.g., 90% neutral/10% sad; 80% neutral/20% sad). Each emotion was represented by 4 actors (2 male and 2 female) for a total of 12 sets of morphed emotional faces. This resulted in 108 morphed facial stimuli that were presented one at a time in random order over two blocks (216 facial stimuli total). Participants were asked to choose which emotion (angry, happy, sad, or neutral) was being presented after viewing each randomly presented morphed face across all increments of morphed emotional faces (i.e., the task included all levels of morph for each of the three target emotions; c.f. Gibb, Schofield, & Coles, 2009).

Sensitivity to identify emotional expressions was measured as the percentage of times the participant correctly indicated the target emotion (angry, happy, or sad) per level of morph. Misclassification of emotional expressions was measured by the percentage of times the participant indicated an incorrect emotion (angry, happy, sad, or neutral) in lieu of the target emotion (angry, happy, or sad) per level of morph.

Procedure

Each eligible youth visited the laboratory to complete the morphed faces task and diagnostic interview, in that order. Parents provided informed written consent for their child's participation; youth provided written assent. The Institutional Review Board approved all procedures. Youth and parents were reimbursed for their participation.

Data Analytic Overview

Diagnostic group differences in youths' sensitivity to identify and misclassify emotional expressions were examined using generalized estimating equations (GEE; Zeger & Liang, 1986). Specifically, we conducted two separate 3 (Depression group: Currently Depressed, Remitted Depressed, Never-Depressed) x 3 (Emotion: Angry, Happy, Sad) x 9 (Morph Level: 10% to 90% morph) GEE analyses. Differences in performance among diagnostic groups was the main focus of the current study, and results will be presented and interpreted within this framework. For the sensitivity analyses, we used the percentage of faces classified as belonging to the target continuum (angry, happy, or sad) per level of morph as the dependent variable. For misclassification analyses, we used the percentage of faces misclassified as being an emotion other than the target emotion for that continuum per level of morph.

Results

Preliminary Analyses

There were no depression group differences in ethnicity or race ($ps > .05$; see Table 1). Consistent with epidemiological studies of youth depression (e.g., Avenevoli et al., 2008), the remitted and currently depressed youth sample consisted of slightly more females than males and more 9th and 6th grade than 3rd grade youth (see Table 1).

Sensitivity Analyses

The raw data for the sensitivity analyses are presented in Figure 1, separately for each emotion type. GEE analysis revealed significant main effects for Depression group ($Wald = 56.40, df = 2, p < .001$), Emotion ($Wald = 2949.61, df = 2, p < .001$), and Morph level ($Wald = 5551.98, df = 8, p < .001$), and a significant Emotion \times Morph level interaction ($Wald = 733.62, df = 16, p < .001$). The Depression group \times Emotion ($Wald = 8.44, df = 4, p = .08$), Depression group \times Morph level ($Wald = 17.13, df = 16, p = .38$), and the Depression group \times Emotion \times Morph level ($Wald = 27.75, df = 32, p = .68$) interactions were nonsignificant. Examining the Depression group differences collapsing across emotion type and morph level showed that currently depressed youth had significantly lower levels of emotion identification ($M_{proportion\ endorsed\ as\ target\ emotion} = .60, SE = .008$) than remitted depressed ($M = .66, SE = .003; Wald = 51.98, df = 1, p < .001, d = .41$) or never-depressed ($M = .65, SE = .002; Wald = 45.63, df = 1, p < .001, d = .36$) youth.

Misclassification Analyses

For misclassifications of facial emotions, we examined whether there were any group differences in the extent to which expressions along a given emotional continuum were misclassified as depicting a different emotion (see Figure 2). We found significant main effects for Depression group ($Wald = 51.15, df = 2, p < .001$), Emotion ($Wald = 65.46, df = 2, p < .001$), and Morph level ($Wald = 282.26, df = 8, p < .001$) and a significant Emotion \times Morph level

interaction ($Wald = 64.19, df = 16, p < .001$). The Depression group \times Emotion ($Wald = 5.99, df = 4, p = .20$), Depression group \times Morph level ($Wald = 25.04, df = 16, p = .07$), and the Depression group \times Emotion \times Morph level ($Wald = 27.00, df = 32, p = .72$) interactions were nonsignificant. The main effect of Depression group was due to the greater number of misclassifications among currently depressed youth ($M = .10, SE = .004$) than remitted depressed ($M = .08, SE = .002; Wald = 28.14, df = 1, p < .001$) or never-depressed ($M = .08, SE = .001; Wald = 44.40, df = 1, p < .001$) youth. To provide a more detailed understanding of these differences, we examined which alternate emotions were endorsed during these misclassifications. We found that currently depressed youth were more likely to misclassify happy and sad faces as angry (happy continuum: $M_{angry} = .06, SE = .006$; sad continuum: $M_{angry} = .06, SE = .006$) than remitted depressed (happy continuum: $M_{angry} = .03, SE = .002, Wald = 32.36, df = 1, p < .001, d = .32$; sad continuum: $M_{angry} = .03, SE = .002, Wald = 49.86, df = 1, p < .001, d = .44$) or never-depressed youth (happy continuum: $M_{angry} = .03, SE = .001, Wald = 48.36, df = 1, p < .001, d = .35$; sad continuum: $M_{angry} = .03, SE = .001, Wald = 69.24, df = 1, p < .001, d = .45$). Currently depressed youth were also more likely to misclassify angry faces as happy (angry continuum: $M_{happy} = .05, SE = .005$) than remitted depressed (angry continuum: $M_{happy} = .03, SE = .002; Wald = 11.50, p < .011, d = .31$) or never-depressed youth (angry continuum: $M_{happy} = .03, SE = .001; Wald = 7.68, p = .006, d = .16$). There were no group differences in the tendency to misclassify sad faces as happy ($ps > .97$) or angry or happy faces as sad ($ps > .09$).

Discussion

The primary aims of this study were to investigate whether currently depressed youth demonstrated a general or specific processing bias in their sensitivity to identify emotional

expressions and whether they exhibited biased misclassification of particular types of emotion, especially misperceptions of negative emotions. Last, we explored whether this effect would be obtained only among currently depressed versus remitted depressed and never-depressed youth.

Consistent with a meta-analysis of the adult literature (Demenescu et al., 2010), we found that depressed youth demonstrated a general deficit in their sensitivity to identify all emotional expressions (angry, happy, and sad) compared with remitted and never-depressed youth.

Although findings differ from Joormann et al.'s (2006) study with currently depressed adults, this finding is compatible with the broader findings among depressed adults (Demenescu et al., 2010). This general deficit may also be in line with the wide range of cognitive deficits observed among depressed individuals (Persad & Polivy, 1993). It is theorized that currently depressed individuals demonstrate an inattentiveness towards others and are more self-focused, which may result in less sensitivity to others' emotional expressions. However, further investigations are necessary as little research has examined emotion processing among depressed youth with these particular methods and stimuli (i.e., morphed emotion faces with full range of intensity).

Conceivably, subtle task differences could affect the discrepancy in findings. For example, our use of the morphed faces task with the full range of emotional intensity as compared to Joormann and colleagues' (2006) task that stopped the task at the earliest emotion detection.

Additionally and partially consistent with our hypothesis, currently depressed youth exhibited biased processing of angry faces when misclassifying sad and happy expressions. Specifically, depressed youth misclassified happy and sad faces as angry at over twice the rate on average when compared with remitted depressed and never-depressed youth (see Figure 2) across all morph levels. Unexpectedly, depressed youth were more likely to misclassify angry faces as happy. Processing of anger is a relatively understudied topic in youth depression;

however, it has been highlighted as an important area based on developmental approaches to emotion (Cole & Hall, 2008). Although further replication is needed due to the current study's small sample size of currently depressed youth, it is possible that depressed youth are more likely than remitted and never-depressed youth to demonstrate general misinterpretations of anger. Our results suggest over-identification of anger when it is not present and under-identification of anger when it is present could lead to interpersonal challenges (Rudolph, 2009) when attempting to interpret an emotionally charged situation.

The current study's findings differ from those in Schepman and colleagues' (2012) study that found depressed youth more frequently misclassified emotional faces as sad. However, Schepman et al. utilized a clinic-referred sample as opposed to a community sample of youth. Although clinic referred sampling generally leads to larger sample sizes ($n = 29$ in Schepman et al.), community samples, as utilized in the current study, increase accuracy of statistical analyses (Cohen & Cohen, 1984) and decrease biases seen in participants seeking treatment (i.e., less representative of the geographical area, greater symptom severity, and higher comorbidity; Goodman, Lahey, Fielding, Dulcan, Narrow, & Regier, 1997). Taken together, our findings are consistent with research demonstrating the link between feelings of anger and depression (Koh, Kim, & Park, 2002), and studies showing those with current depression (e.g., Beevers et al., 2009) exhibit processing biases to interpersonally threatening facial expressions.

Finally, contrary to hypotheses, biased processing of emotional faces depended upon a diagnosis of current depression. Youth with remitted depression demonstrated patterns of sensitivity to and misclassification of emotional expressions similar to never-depressed youth. This finding suggests that the general lack of sensitivity to emotion and the misperceptions of threat may be a state-dependent feature of depression as opposed to a more trait-like

predisposition to disorder. Although these findings differ from the adult literature (e.g., LeMoult et al., 2009), LeMoult and colleagues investigated biases in emotion identification among women with a history of recurrent depression (i.e., at least two or more past episodes of depression), whereas the current study did not require participants to have experienced more than one past episode of depression. Perhaps adults with severe, recurrent depression experience more cognitive and emotional impairment outside of a depressive episode, thus exhibiting biases when not currently depressed. Examining the effect of remitted depression severity and recurrence within youth samples will be necessary before drawing firm conclusions on whether emotion identification biases exist as a state-dependent or trait-like vulnerability factor.

These findings have important implications for understanding youth depression and its maintenance, though future replications are needed given this is one of the first studies to provide a preliminary examination of biased emotion processing among depressed youth. Specifically, misperceptions of anger along with decreased sensitivity to emotional expressions may play a role in depression maintenance by contributing to a transactional cycle of misperceptions of social threat (Fischer & Roseman, 2007) followed by depressive symptoms increases (Carton et al., 1999). Additionally, these findings suggest a target for intervention. As depressed youth are more likely to both falsely perceive non-threatening emotions as hostile and misperceive angry emotions as happy, therapy could incorporate a greater emphasis on emotion classification and utilization of additional social cues (e.g., tone of voice, content of speech, or gestures) to assist youth to more accurately perceive the degree of threat in interpersonal interactions.

There were several strengths of this study. Most prior studies have investigated sensitivity to identify emotional expressions in clinically depressed adults (Joormann & Gotlib, 2006), and only one study has examined identification and misclassification of emotion among

youth with comorbid depression and conduct disorder (Schepman et al., 2012). Therefore, this is one of the first studies to examine differences in the sensitivity to identify emotion among depressed youth and the misclassification of emotion among depressed individuals of any age. Additionally, the present study is the first to directly compare emotion processing biases in currently and remitted depressed youth. Last, we utilized a task that examined sensitivity to and misclassification of facial expressions across the full spectrum of emotional intensity rather than to only prototypical expressions.

Limitations of the study provide avenues for future research. Although we examined several facial expressions (angry, happy, sad), future research can examine whether depressed youth demonstrate biased perception of other negative emotions (e.g., fear or disgust) or whether misperceptions are specific to anger. Additionally, this study utilized a community sample of youth that was representative of the target population, but resulted in a relatively smaller sample size in the currently depressed group. Due to the small sample size of currently depressed youth, there was not enough power to examine higher-order interactions, which is a notable limitation; therefore, future studies with larger sample sizes are needed for replication and examination of theoretically relevant moderators, such as gender or age.

In sum, currently depressed youth differ from remitted depressed and never-depressed youth by exhibiting a general lack of sensitivity to identify emotion and misperceptions of anger when misclassifying emotional expressions. These preliminary findings suggest that depression may influence the likelihood of identifying emotions and misperceiving emotions as interpersonally threatening, which could indirectly contribute to the maintenance of a depressive episode.

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Table 1.

Descriptive Statistics by Depression Categorization

	Never- Depressed (n=200)	Remitted Depressed (n= 68)	Currently Depressed (n= 12)	Total Sample (n= 280)
Gender [†]				
Girls	52%	66%	67%	56%
Boys	48%	34%	33% [†]	44%
Grade***				
3 rd	37%	16%	8%	30%
6 th	38%	29%	25%	35%
9 th	25%	55%	67%	34%
Ethnicity				
Hispanic	9%	7%	8%	9%
Non-Hispanic	91%	93%	92%	91%
Race				
Caucasian	56%	78%	75%	63%
African American	19%	12%	17%	17%
Asian/P. Islander	19%	6%	8%	16%
Other	6%	4%	0%	5%

Note. Significant Depression group differences indicated by [†] < .10 and ***p<.001.

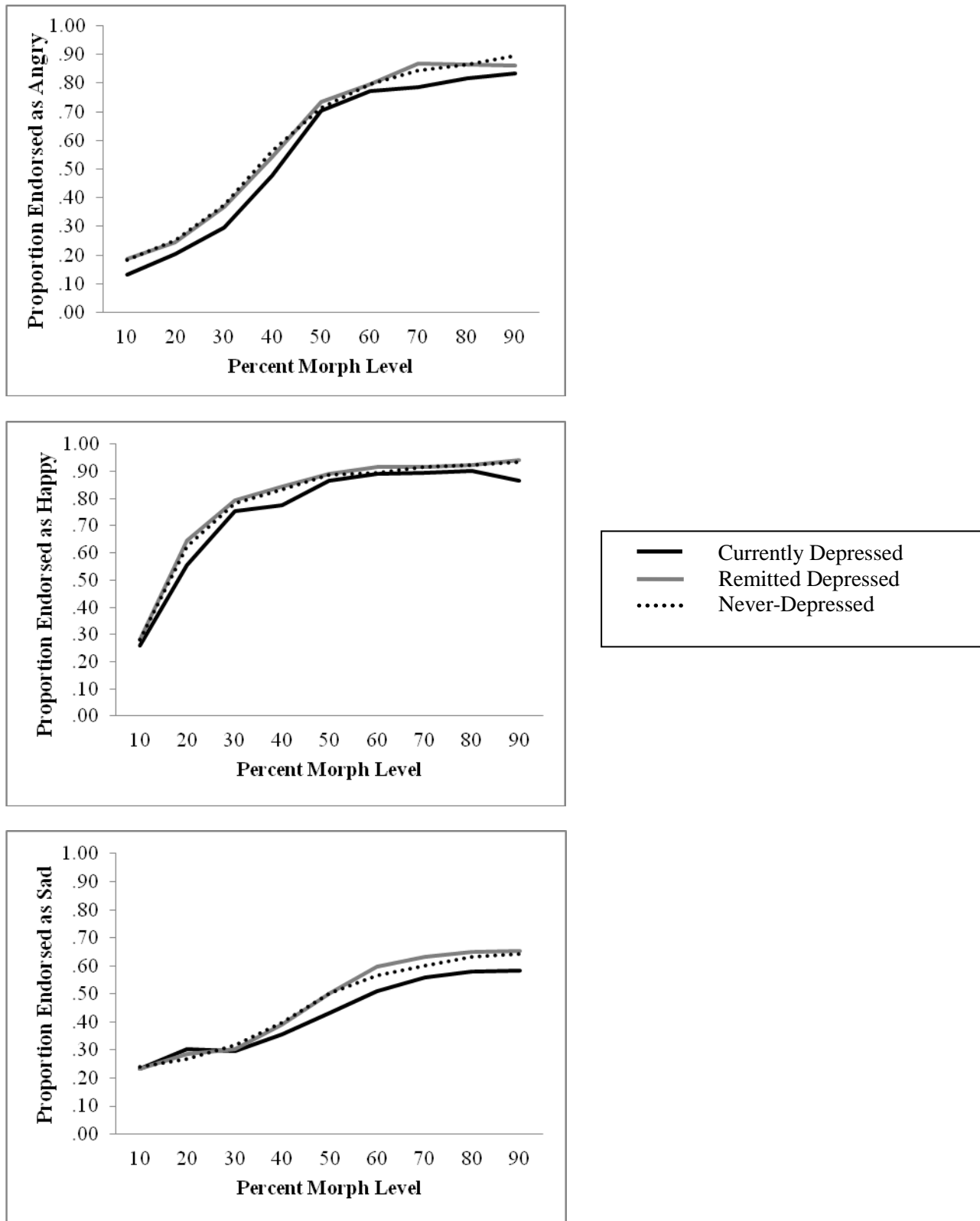


Figure 1. Sensitivity to identify angry (top), happy (middle), and sad (bottom) emotional faces separated by diagnostic status.

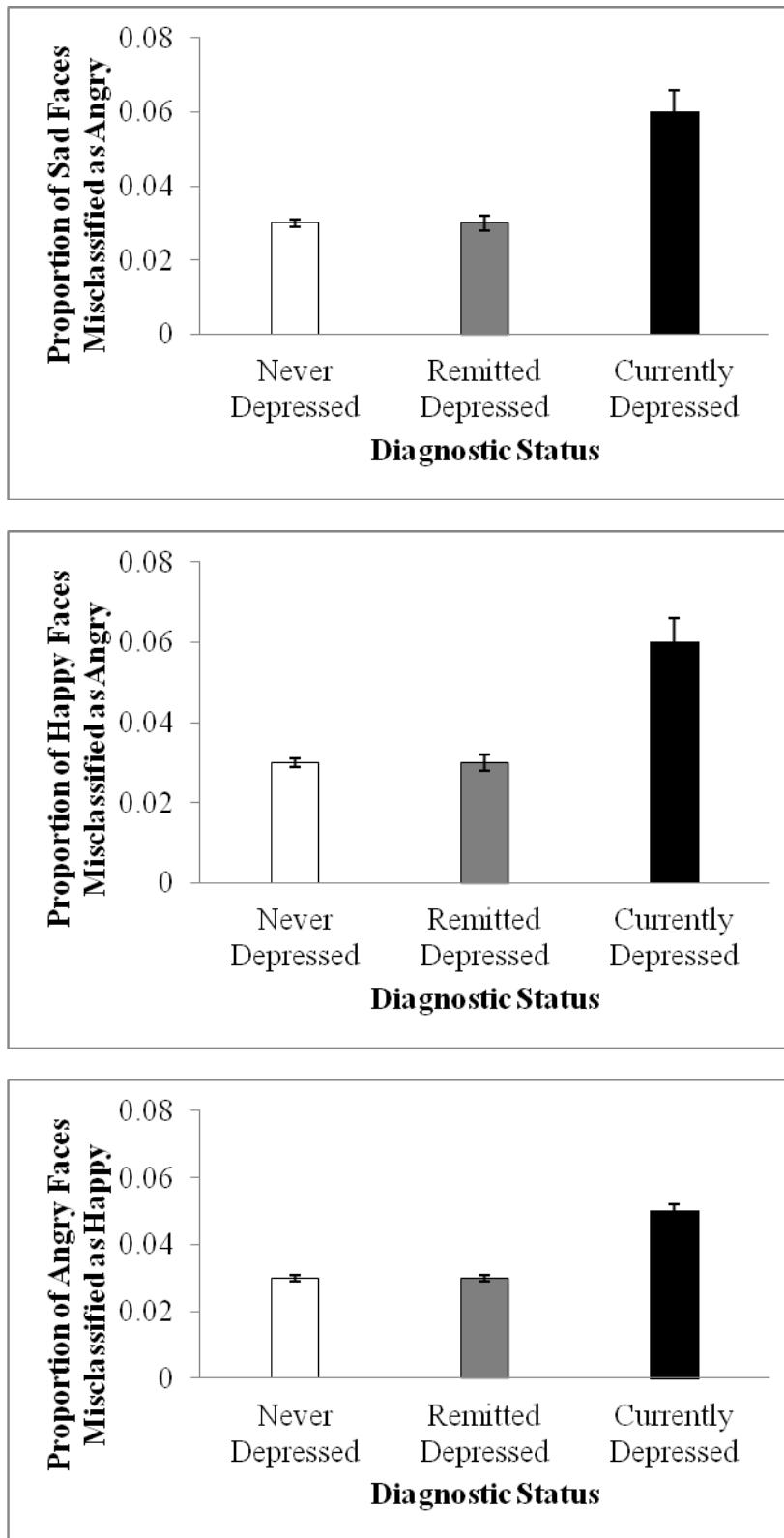


Figure 2. Misclassification of sad (top) and happy (middle) faces as angry and misclassification of angry faces as happy (bottom) separated by diagnostic status.