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Emerging depression is associated with face memory deficits in adolescent girls

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Abstract

Objective—To examine the association between memory for previously-encoded emotional faces and depression symptoms assessed over four years in adolescent girls. Investigating the interface between memory deficits and depression in adolescent girls may provide clues about depression pathophysiology.

Method—Participants were 213 girls recruited from a longitudinal, community-based study; the majority was African-American. Scores on depressive screening measures at age 8 were used to increase the base rate of depression. Depression symptoms and diagnoses were assessed annually for four years. In year four, when the girls were 12-13 years old, a face emotion encoding task was administered during which ratings were generated in response to sad, fearful, angry, and happy faces. A surprise memory task followed where participants identified which of two faces, displaying neutral expressions, they had seen previously.

Results—Girls with higher depression symptom levels from ages 9-12 years evidenced lower accuracy in identifying previously-encoded emotional faces. Controlling for IQ, higher depression symptom level was associated with a memory deficit specific to previously-encoded sad and happy faces. These effects were not moderated by race.

Conclusions—Individual differences in face memory deficits relate to individual differences in emerging, early adolescent depression, and may be vulnerability markers for depression.

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Keywords

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Introduction

Major depressive disorder (MDD) is highly prevalent in adolescents, with estimates ranging from 14-20%.[1] Depressive disorders are also the most common and impairing of mental and medical disorders among females. Between ages 15-50 years, 15-20% of women experience MDD.2 Confirming the well-documented sex and age effects on MDD3-4, a meta-analysis of epidemiologic studies demonstrated that MDD rates double from childhood to adolescence particularly among girls.[5] Thus, peri-adolescence is a critical period for understanding vulnerabilities for depression in females.[6]

Contextual factors such as race and poverty further influence the emergence of depression. Nearly 35% of African-American children and adolescents live in poverty, roughly three times the rate for European-American youth.[7] Among both adults and adolescents the mental health outcome most consistently linked to stressful life contexts, such as poverty, is depression.[8] Poverty and inequality contribute a range of stressors that lead to significant racial and socio-economic disparities in mental health, and individuals from minority groups are unlikely to receive mental health services.[9-11] Low-income urban African-American youth, therefore, face heightened risk for recurrent and severe depression.[12]

Cognitive theories of depression and associated empirical evidence indicate that one marker of vulnerability to depression is memory perturbation.[13-15] Indeed, a well-replicated finding in adult depression is memory dysfunction[16-18], including poor overall memory[19] and memory bias.[20-21] Perturbed memory in adults has been documented in older adults afflicted with MDD.[19, 21] The age at which depression-related memory abnormalities typically manifest, however, is unclear. Potential cognitive vulnerability markers should be evident prior to disorder onset and in those at high risk for the disorder.[22] Stressful life events are suggested to further increase risk for depression by interacting with vulnerabilities.[23] Thus, a critical question is whether memory perturbations can be identified reliably in female adolescents, particularly in nonclinical samples with heightened contextual risk for depression.

Of particular relevance to adolescent depression is emotional memory, the capacity to remember stimuli of various emotional valences. Three sets of findings guide this focus. First, depression and risk for depression in youth are linked to memory biases for negative versus positive information[24], negative self-description[25], impaired memory for negative events[26], and overgeneral memory biases.[27-29] Second, risk for depression coincides with emotional memory maturation during adolescence.[30-31] Third, neuroimaging studies of emotional memory implicate brain structures common to MDD, including the amygdala, hippocampus, and prefrontal cortices.[32-33] This is particularly salient given that adolescence is characterized by protracted maturation of cognitive-regulatory neural circuits and hyper-reactivity to emotional stimuli in affective neural circuits.[34-35]

Adolescent depression has been associated with memory deficits following emotional-face processing. Results from one study demonstrated reduced memory for fearful faces in adolescents with remitted MDD whose parents had MDD compared to those offspring with no MDD.[36] A second study, in which the same task was administered in the context of neuroimaging, suggested that amygdala dysfunction might account for the previously found memory deficit in adolescent MDD.[37] Both studies, however, had limitations. In neither

study were sad facial displays used, a stimulus relevant to depression. In both studies relatively complicated encoding and recognition strategies were utilized, yielding both ceiling[37] and floor effects.[36] Finally, both studies used clinic-based samples, in which various pathophysiological findings are difficult to replicate.[38] The current study addresses these limitations.

In the present study, face-memory function was investigated in a sub-study of girls at risk for depression drawn from a community sample that was oversampled based on neighborhood poverty and enriched for depression risk based on high scores on depressive screening measures collected in preadolescence. Over half of the sample was African-American. We used a face-memory task to assess adolescents' ability to form representations of individuals depicting high-valence emotions. We then assessed the ability to later recognize these individuals when depicting neutral expressions. We hypothesized that memory deficits of previously encoded emotional faces would be associated with higher depression symptom levels across preadolescence, and we expected that memory for previously encoded sad faces would be most compromised in relation to depression. In addition, we examined whether race moderated depression and memory associations based on evidence that African-American girls face higher risk for depression than European-American girls[39] and race differences in certain risk factors are associated with depression.[40]

Method

Participants

Participants were girls and their biological mothers from the Pittsburgh Girls Study (PGS, *N*=2,451), a prospective study of the development of Conduct Disorder. The PGS recruited 5-8 year old girls living in the city of Pittsburgh and oversampled girls living in low income neighborhoods. The oversampling led to relatively equal numbers of African-American and European-American girls (52% were African-American) in the PGS. From among the youngest PGS participants, girls were selected to participate in the PGS-Emotions (PGS-E) sub-study who either screened high on standardized depressive screening measures at age 8, or were from a random selection of the remaining PGS girls.[39] This approach was used to increase the base rate of depression as the girls entered adolescence. Depression screeners included the Short Moods and Feelings Questionnaire41 and the Child Symptom Inventory. 42 Girls scoring ≥75th percentile by self-report, mother's report, or both comprised the screen-high group (*n*=135), which included significantly more African-American than European-American girls. From the remaining PGS participants scoring <75th percentile on the depression screeners, 136 girls were randomly selected and matched to the screen-high group on race. Of the 271 eligible families for the PGS-E, 8 were not recruited (e.g., the family moved). Of the remaining 263 families, 232 (88.2%) participated, 25 (9.5%) declined participation, and 6 (2.3%) could not be scheduled for an assessment. The first PGS-E assessment occurred at age 9 years. Retention rates remained high across annual assessments (e.g., Year 02=97.8%; Year 03=97.0%). In Year 04, 219 (94.4%) participated, 5 (2.2%) declined participation, and 8 (3.4%) could not be scheduled. The current study includes 213 girls who completed the face-emotion task in Year 04. Of 219 girls assessed in Year 04, 4 completed a phone assessment but not the face-emotion task and 2 had unusable task data.

Mothers' average age was 35.7 years (*SD*=7.0). Most of the mothers (71.9%) were single parents, 16.4% had <12 years of education, and 52% had received public assistance. Families of African-American girls (63.1%) were more likely than families of European-American girls (26.1%) to be public assistance recipients (χ^2=2.65, p<.001).

Procedures

Girls and their mothers completed an annual assessment of DSM-IV depression symptoms. In Year 04, when the girls were on average 12 years of age, the Emotional Faces Task was administered. Written informed consent was obtained. The University of Pittsburgh Institutional Review Board approved all study procedures.

Measures

Depression—Current depression symptoms (i.e., past month) were measured using the Kiddie-Schedule for Affective Disorders and Schizophrenia for School-Age-Children-Present- and Lifetime-Version (K-SADS-PL), a semi-structured diagnostic interview administered to the girl and her mother.[43] Depression symptoms were assessed rigorously for being present most of the time (i.e., interviewers are trained to probe for information to determine whether a behavior meets symptom criteria). All depression symptoms were assessed, including mood disturbance (i.e., sadness, irritability) or anhedonia. Depression diagnoses were generated from combining caregiver and child assessments and according to symptom threshold, duration, and frequency for DSM-IV-based major and minor depression. Inter-rater reliability was assessed by having a second interviewer code the interview, using 25% of interviews randomly selected for this purpose. Average ICCs were . 96 and .95 for total number of symptoms from youth- and caregiver-reported data, respectively. Average kappa coefficients for minor/major depressive disorders from youth- and caregiver-reported data were .89 and .91, respectively.

Emotional faces task—Past work on adolescent depression and face memory has not included sad facial stimuli and previously used tasks generated either extremely high or low memory scores. To address this, we adapted earlier versions of an emotional-faces task.[36-37] First, we included sad face stimuli, in addition to task instructions that directed participants' attention to subjective and objective perceptions of sadness during face encoding. Although our focus is on memory, by including both encoding and recognition tasks we could assess the degree to which deficits emerged at face encoding or face recognition. Second, we modified the face-recognition procedures (see below).

The task involved viewing 32 faces (8 sad, 8 fearful, 8 angry, 8 happy) presented pseudo-randomly for 4 s within each of three instruction sets (displayed for 3 s) four times. Participants rated each face from 1=not at all to 5=very much so on: "How sad is this person?" "How sad does this face make you feel?" and "How wide is the nose?" Reaction time (RT) was recorded per rating. Inter-trial interval was 750-1250 msec. A surprise recognition task was administered 20 minutes later. Thirty-two neutral face pairs were presented side-by-side. One face was previously viewed at encoding and one was novel. Of the two neutral faces, participants identified which one they had seen previously by pressing 1 if the recognized face was on the left side of the screen or 2 if the recognized face was on the right side. RT was also recorded. Prior task versions used presentations of one isolated neutral face per trial.

Stimuli were from three standardized sets of gray-scale photographs of 56 actors.[44-46] Participants viewed 32 actors, with each actor randomly assigned to display one of the four expressions. An actor might be randomly chosen to portray "anger" across the task for one participant; this same actor might portray "sad" for another subject and "happiness" for yet another. This design controlled for variability in non-emotional features of the actors (e.g., hair color). Actors were racially and sexually diverse; 33% of the actors were African-American or Asian-American.

Race—Sixty-one girls (28.6%) were identified as European-American, 143 (67.1%) as African-American, and 9 (4.2%) as African-American/Multi-racial. The 9 African-American/Multi-racial girls differed from European-American girls in depression symptoms (p=.007), but did not differ from African-American girls not identified as multiracial (p=.48). These 9 girls were grouped with the African-American girls, yielding 152 African-American/Multi-racial and 61 European-American girls.

IQ—Verbal IQ was assessed with Vocabulary and Similarities subtests of the Wechsler Intelligence Scale for Children-III-R [47] administered by trained interviewers in the home when the girls were age 10 years. This short-form has excellent psychometric properties relative to the full-length Verbal Scale.[48-49]

Pubertal stage—Pubertal stage was measured using the Physical Development Scale (PDS) and associated scoring[50-51], which includes four questions about growth spurt, body hair, breast development, and changes in skin rated on 4-point scales and one yes/no question about menstruation onset. We used maternal report, which more closely relates with physical exam scoring than does child self-report.52 Based on age 12 pubertal status, girls were classified into three pubertal groups: pre-pubertal/beginning (n=14), mid-pubertal (n=42), and advanced/post-pubertal (n=147). Pubertal status data was unavailable for 10 girls. This approach has been widely used in other studies[3], is consistent with the normal sequence of pubertal development identified by Tanner[53], has shown good reliability and validity[54], and convergent validity with Tanner staging by physical exam.[55]

Data Analysis

To test within-group differences in relation to depression on the encoding and recognition tasks, respectively, depression groups were categorized as: full MDD in ≥1 year (n=45); subthreshold MDD in ≥1 year but never having met full criteria for MDD (n=36); and no history of subthreshold/full MDD (n=132) (Table 1). Initial analyses tested potential depression-group and race-group effects to determine task performance variation based on face-emotion or instruction set. Reaction time serves as a measure of overall stimulus processing by indexing the capture of attention and encoding. Two 3 (depression group) x 2 (race) x 3 (instruction-set) x 4 (face-emotion) repeated measures analyses of variance evaluated differences in ratings and RT per face-emotion and instruction-set. A set of similarly constructed ANOVAs was conducted for recognition accuracy and recognition RT per face-emotion. IQ was covaried in all analyses. These analyses tested for significant 2- or 3-way interactions with depression group or race.

Primary analyses used average depression symptom counts and variability (SD) of depression symptom counts across four annual assessments. We used symptoms given low base-rates of MDD diagnoses and to test whether associations between memory and depression symptoms could be observed before onset of depressive disorders. Spearman's ρ coefficients were computed to examine associations of key variables with depression symptoms. Primary analyses used hierarchical multiple regression to predict emotional-face memory by mean depression symptom counts and variability of depression symptom counts, across four annual assessments. Face memory accuracy was calculated as the percent of faces correctly recognized overall and per emotion. IQ correlated with mean depression symptom counts (ρ=−.39, p<.001), variability of depression symptom counts (ρ=−.23, p<.01) and overall recognition accuracy (ρ=.28, p<.001). Puberty status correlated with mean depression symptoms (ρ=.18, p<.05) and race (ρ=.21, p<.01) but not with any of the task performance measures; thus, puberty was not included in further analyses given our interest in predicting face memory accuracy. IQ was centered on the sample mean and included as a covariate in all analyses; two participants were missing IQ scores. We applied a

theoretically-driven approach in designing our models to assess contributions from known individual-level correlates and hypothesized depression correlates to variance in face memory accuracy. Thus, IQ and race were entered on step one and the depression variable in step two to evaluate its unique contribution to memory indices. An interaction term was added in a third step to evaluate the potential moderating effect of race on depression in predicting face memory accuracy.

Results

Depression Diagnosis

Encoding task—Depression group and race did not influence ratings or RT. No significant interactions emerged between depression group or race and face-emotion or instruction-set. All girls, regardless of depression group and race, encoded the faces similarly, regardless of face-emotion or instruction-set, based on their ratings and RTs (Table 2).

A significant face-emotion x instruction-set effect was found on ratings (F[6, 1224]=5.78, p<.001). These variations followed expectable patterns suggesting that participants performed the task appropriately (e.g., sad faces were rated as most sad, happy faces as least sad). Similarly, a significant face-emotion x instruction-set effect was found on RT (F[6, 1224]=3.18, p<.01).

Recognition task—A significant group effect was found on recognition accuracy, F(2,204)=3.49, p<.05. Girls with MDD in at least one of four assessment years had a lower accuracy for identifying previously-encoded emotional faces relative to girls with no MDD history (M=.81 versus .76, p<.01). There were no significant differences in accuracy between girls with a history of threshold and subthreshold MDD, or between girls with no MDD history and subthreshold MDD. None of the within-group effects were significant nor did they interact with group.

A similar repeated-measures ANOVA was conducted for RT to indicate recognition of whether a face was old or new. Neither within- or between-group effects were significant; the groups responded in a similar amount of time when indicating whether they recognized each of the different emotion faces.

Depressive Symptoms

Correlations between predictors and emotional-face memory indices are presented in Table 3. IQ, race, accuracy recognizing faces overall, and accuracy recognizing previously-encoded happy and sad faces correlated significantly with depression symptoms averaged over four years. These associations indicated that lower IQ scores, African-American race, and lower accuracy recognizing previously-encoded faces, particularly those depicting happiness and sadness, were associated with higher depression symptom levels. IQ and race were associated with depression symptom variability across time; specifically, lower IQ and African-American race were associated with greater variability.

Mean symptom levels—When entered on step one, IQ accounted for 8% of the variance in overall accuracy. Race did not significantly account for additional variance (Table 4). Depression symptom count across time was entered on step two, explaining an additional 2% of variance in overall accuracy. Specifically, a higher level of depression symptoms was associated with lower accuracy in remembering previously encoded faces. The race x depression interaction was entered on step three. Race did not moderate the association between depression and accuracy.

Regression analyses were similarly conducted for each emotion (Table 4). IQ significantly accounted for variance in recognition accuracy for sad faces. When depression symptoms were added on step two, it was the only factor that remained significantly associated with accuracy in recognizing previously encoded sad faces, accounting for an additional 5% of variance. Similar results were found for happy faces. IQ significantly accounted for variance in recognition accuracy on step one. When IQ, race, and depression symptoms were entered on step two, only depression symptoms remained associated with accuracy, accounting for an additional 2% of variance. In both models, higher depression symptom levels predicted lower accuracy when remembering previously encoded sad and happy faces, which is about a 15% decrease in accuracy from the lowest to highest levels of symptoms. For fearful faces, IQ was the only significant predictor. There were no significant predictors of accuracy in recognizing angry faces. Race did not moderate depression and accuracy for any emotion-specific memory indices. Figure 1 depicts the associations between depression symptoms and accuracy in recognizing previously-encoded faces depicting each emotion, adjusted for IQ and race.

Symptom variability—A similar set of regressions tested whether variability in depression symptoms over time, and the potential moderating effect of race, predicted face memory. IQ was the only significant predictor associated with overall accuracy and accuracy for fearful and sad faces after depression variability and race x depression variability were added. None of the predictors were associated with memory performance. Thus, depression symptom variability was not associated with memory function and race did not moderate depression variability and memory.

Effects of RT—Correlations tested associations between RT, face memory, and depression. Overall RT for recognizing whether a face was old or new (regardless of emotion) was not associated with IQ, race, depression symptoms, or depression symptom variability. RT for happy faces was associated with depression variability (ρ=.16, p=.02), whereby higher variability in depression symptoms was associated with a longer latency to indicate recognition of previously-encoded happy faces. A partial correlation (using a Spearman correlation matrix) between accuracy in recognizing faces that had depicted happiness and average depression symptoms, controlling for RT to indicate recognition, remained significant (r=−.14, p<.05). This suggests that a slowed RT for recognizing faces that had depicted happiness did not mediate the association between memory deficits for happy faces and depression symptoms.

Discussion

We tested hypotheses about associations between emerging depression and memory for faces that previously depicted various emotions in a large, well-characterized sample of girls. As predicted, the results indicated that girls' depression symptoms during preadolescence were associated with compromised ability to recognize neutral faces of actors who depicted high-valence emotional expressions at encoding. These associations appeared specifically for sad and happy faces; depression symptoms were not associated with memory for faces that had shown fear or anger. Race did not moderate associations between face memory and emerging depression.

Results from the present study extend the existing data on memory deficits and depression in several ways. First, our novel face encoding and recognition task offers advantages over other paradigms. Many emotional memory tasks present emotional content using words; however, variability in reading and language abilities may be influenced by depression[56] and verbal stimuli may have reduced emotional salience to adolescents.[57] Using facial stimuli in the current task offset these methodological issues.

Second, facial stimuli can depict various emotions, allowing for emotion to be manipulated and other factors held constant. We designed the current task to include sad faces, which have not been used in previous iterations of this task. By doing so, we could assess response to stimuli that mimic the experience of depression. The current task also included different encoding instructions than in previously used renditions of this paradigm. These instructions cued participants to subjective and objective aspects of sadness. Again, the aim was to direct attention to sadness and assess whether deficits emerged during encoding or recognition. The task appeared successful, as illustrated by the finding that all participants, regardless of race or depression, encoded the stimuli similarly whereas face memory varied by depression symptom levels.

Third, prior studies indicated difficulty with variants of this recognition paradigm, with participants showing better abilities to identify novel faces as novel, possibly since all photographs viewed at recognition are truly novel. In contrast, recognizing photographs of previously seen actors, now depicting neutral expressions, is more difficult.[36] In the current study's task, we combined both recognition presentations, whereby face-pairs shown per trial included a previously seen face and a novel face and both faces displayed neutral expressions, an expression not seen during encoding.

Finally, the present study used a unique sample enriched for depression risk from a larger, community-based study not commonly found in cognitive neuroscience. Participants' depression histories were well documented from 9-12 years of age. Moderate stability in depression symptoms during childhood has been observed in this sample and half of the sample was African-American; thus, the girls face high risk for MDD. In addition, the sample was well characterized on depression using a DSM-IV-based interview with high inter-rater reliability. Thus, depression symptom assessments were both clinically-sound and relevant to diagnosed depression, which is useful given the typically low base-rates of diagnosed depression during this peri-adolescent period.[39]

While the current methods center on memory for previously-encoded facial emotions, it is unlikely that the results reflect broad perturbations in face emotion processing. Relative to the current and prior findings on face-emotion *memory*, other work finds no association between adolescent MDD and face-emotion *labeling* deficits.[58] This suggests that different neuropsychological processes may be implicated in different mood disorders during adolescence. For adolescent depression, memory for faces that had depicted different emotions is impaired whereas emotion labeling and initial encoding of emotion appears unaffected, as supported by our results indicating no MDD group differences in encoding.

Our results showing reduced memory for happy faces align with evidence of individual differences in positive emotionality and depression in youth. For example, a recent study showed that deficits in generating specific memories to positive cues, but not to negative cues, during an autobiographical memory test were associated prospectively with depression symptoms.[59] Cross-sectional neuroimaging studies of adolescent depression have revealed blunted striatal and OFC response in depressed adolescents during reward processing, possibly reflecting lower motivation for positive stimuli.[60] In addition to valence, stimulus arousal level may influence recognition memory. For example, happy and sad faces may be perceived as less arousing than angry and fearful faces, which suggests that the recognition deficits found here may occur for less arousing stimuli. Further work is needed that accounts for the arousal level of to-be-remembered stimuli.

The current study has some limitations. First, the encoding task had a small number of trials when parsed by emotion-type and instruction-set. Future work might include alternative designs with fewer emotion types, allowing more emotion replicates or more trials overall.

Alternative viewing designs could also further specify the psychological processes engaged during encoding. However, pilot data showed poor memory unless adolescents repeatedly viewed each face, but rating the same face repeatedly reduced adolescents' attention with each viewing, suggesting that performing the same rating multiple times does not guarantee invariant psychological processes across viewings. Thus, varying instructions helps maintain participants' attention throughout the task.

Second, it was not possible to calculate a measure of signal detection threshold (*d'*) because the recognition task presented face stimuli in pairs. The *d'* measure represents the degree to which an individual differentiates true targets from distractor items.[61] This difference in assessing memory limits direct comparison to previous work that measured memory performance with *d'*. Third, the potential role of comorbid conditions (e.g., anxiety, disruptive behaviors) was not tested. We have previously reported that early emerging depression symptoms are stable[39] and are the best predictors, in comparison to anxiety symptoms, of adolescent-onset depression.62 Nonetheless, co-occurring anxiety and depression symptoms may yield a unique profile of face-emotion memory performance. Fourth, other memory tests were not collected; as such, future work would benefit by their inclusion to test for memory deficits specific to emotional faces. Finally, memory performance was assessed at one time-point and depression symptoms at four annual time-points. More research is needed to assess depression and memory performance at multiple time-points in order to prospectively track their association across adolescence.

Our findings have clinical implications. Targeting symptoms and sub-syndromal forms of depression in preadolescence before development of the full disorder in adolescence may be one avenue toward reducing the morbidity associated with this disorder. Research that provides further evidence for the validity of early emerging symptoms as targets of intervention, and reveals processing deficits associated with early emerging symptoms may lead to opportunities to propose and test novel prevention strategies. Results from the present study have the potential to improve identification of early vulnerability markers and endophenotypes of depression in females, particularly for those at heightened risk due to stressful living situations.

In summary, adolescent girls at risk for depression demonstrate overall and emotion-specific memory deficits for previously-encoded faces that were associated with depression symptoms ascertained longitudinally. This association remained after accounting for IQ and race, and was not moderated by race. These findings lend themselves to further hypotheses about the neurophysiological mechanisms linking memory deficits and depression in adolescent females. For example, future neuroimaging work could use this face-emotion task to test whether functional neural alterations account for the observed associations.

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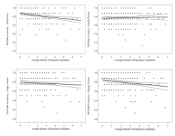

Figure 1.
Age 12-13 Accuracy for Recognizing Emotional Faces Predicted by Age 9-12 Depressive Symptoms

Table 1

Sample Descriptive Information by Depression Group

	No MDD (*n*=130)	Subthreshold MDD (*n*=36)	MDD (*n*=45)
African American Race, % (*n*)	68.3 (90)	77.8 (28)	75.6 (34)
Age 12 Pubertal Status, % (*n*)[a]			
Pre- or beginning pubertal	9.6 (12)	0 (0)	4.4 (2)
Mid-pubertal	20.8 (26)	30.3 (10)	13.3 (6)
Advanced or post pubertal	66.9 (87)	69.6 (23)	82.2 (37)
Depressive Symptoms Year 1, *M* (SD)	1.54 (1.52)	2.58 (1.48)	4.78 (1.72)

Note: Groups were based on presence of subthreshold major depressive disorder (MDD) or MDD diagnosis in at least one of four annual assessments.

[a] Age 12 pubertal status was unavailable for 8 girls (5 with no MDD; 3 with subthreshold MDD).

Table 2

Encoding Task Performance by Face-Emotion, Instruction-Set, and Depression Group

	Rating (1-5), mean(*SE*)[a]			Reaction Time (ms), mean(*SE*)[b]		
	No MDD (*n*=130)	**Subthreshold MDD (*n*=36)**	**MDD (*n*=45)**	**No MDD (*n*=130)**	**Subthreshold MDD (*n*=36)**	**MDD (*n*=45)**
How sad is this person?						
Sad	3.22±.08	3.18±.16	3.19±.14	2156.78±88.37	2209.03±181.33	1989.15±157.09
Fearful	2.57±.09	2.72±.18	2.48±.16	1999.00±70.26	2024.07±144.19	1998.29±124.91
Angry	2.65±.11	3.06±.23	2.52±.20	2012.47±66.93	1989.20±137.34	2023.34±118.97
Happy	1.21±.05	1.11±.09	1.20±.08	1439.28±49.24	1461.43±101.05	1496.85±87.54
How sad does this face make you feel?						
Sad	2.35±.09	2.29±.19	2.53±.17	1826.40±70.51	2003.53±144.69	1681.63±125.35
Fearful	1.99±.09	1.98±.19	2.05±.16	1781.87±71.75	1692.32±147.23	1651.41±127.55
Angry	2.05±.11	2.12±.22	2.17±.19	1772.82±71.08	1726.47±145.86	1686.86±126.35
Happy	1.30±.05	1.19±.10	1.24±.09	1374.48±55.86	1374.96±114.63	1445.86±99.31
How wide is their nose?						
Sad	2.42±.07	2.25±.14	2.52±.12	1947.57±69.63	1756.75±142.88	1901.09±123.78
Fearful	2.55±.07	2.37±.15	2.61±.13	1890.46±61.66	1879.57±126.52	1809.75±109.61
Angry	2.91±.07	2.74±.15	2.84±.13	1934.78±58.36	1907.53±119.76	1824.38±103.74
Happy	2.77±.08	2.67±.16	2.83±.13	1861.57±60.21	1941.70±123.55	1800.74±107.03

Note: Groups were based on presence of subthreshold major depressive disorder (MDD) or MDD diagnosis in at least one of four annual assessments.

[a] Ratings were 1=not at all, 5=very much so.

[b] Higher RT=longer latency to rate. Mean IQ was covaried.

Table 3

Spearman Associations between IQ, Race, Face Memory, and Depression Symptoms across Four Years (*N*=213)

	Depression symptoms (Mean)	Depression symptoms (*SD*)
IQ	−.392***	−.239***
Race (0=European-American; 1=African-American)	.337***	.169*
Face Memory Accuracy		
Overall	−.177**	−.106
Sad	−.242***	−.093
Fearful	−.063	−.032
Angry	−.075	−.050
Happy	−.145*	−.097

Note:

* *p*<.05

** *p*<.01

*** *p*<.001

Table 4

Standardized (S) and Unstandardized (US) Coefficients for Hierarchical Regression Analyses Predicting Face Memory Overall and by Emotion (*N*=211)

	Predictors					
	Step 1		Step 2	Step 3		
Face Memory Accuracy	**IQ**	**Race**	**Depression Symptoms**	**Depression Symptoms x Race**	**R^2**	**FΔ**
Overall						
Step 1 β S/US	.28/.002	.005/.001			.08	8.49***
Step 2 β S/US	.22/.001	.04/.009	−.18/−.01		.10	5.85*
Step 3 β S/US	.21/.001	−.003/−.001	−.25/−.02	.11/.005	.11	1.03
Sad						
Step 1 β S/US	.19/.002	.03/.01			.03	3.29*
Step 2 β S/US	.11/.001	.07/.02	−.23/−.02		.08	9.99**
Step 3 β S/US	.12/.001	.11/.04	−.17/−.02	−.10/−.006	.08	0.74
Fearful						
Step 1 β S/US	.24/.002	−.03/−.01			.07	7.26**
Step 2 β S/US	.25/.002	−.03/−.01	.03/.004		.07	0.21
Step 3 β S/US	.24/.002	−.11/−.04	−.11/−.01	.22/.02	.08	3. 78t
Angry						
Step 1 β S/US	.12/.001	−.03/−.01			.02	1.96
Step 2 β S/US	.09/.001	−.02/−.006	−.08/−.01		.02	1.19
Step 3 β S/US	.09/.001	−.03/−.01	−.11/−.01	.04/.003	.03	.10
Happy						
Step 1 β S/US	.17/.002	.04/.02			.03	2.71t
Step 2 β S/US	.12/.001	.08/.03	−.18/−.02		.05	6.03*
Step 3 β S/US	.11/.001	.04/.01	−.26/−.03	.11/.009	.06	1.02

Note: Step 1 *df*=2, 208; Step 2 *df*=3, 207; Step 3 *df*=4, 206.

*$p<.05$

**$p<.01$

*** $p<.001$