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Subjective social status and neural processing of race in Mexican American adolescents

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Abstract

Adolescence is a sensitive period for sociocultural development in which facets of social identity, including social status and race, become especially salient. Despite the heightened importance of both social status and race during this developmental period, no known work has examined how individual differences in social status influence perceptions of race in adolescents. Thus, in the present study, we investigated how both subjective social status and objective socioeconomic status (SES) influence neural responses to race. Twenty-three Mexican American adolescents (15 females; mean age = 17.22 years) were scanned using functional magnetic resonance imaging while they viewed Black and White faces in a standard labeling task. Adolescents rated their subjective social status in US society, while their parents responded to questions about their educational background, occupation, and economic strain (objective SES). Results demonstrated a negative association between subjective social status and neural responses in the amygdala, fusiform face area, and medial prefrontal cortex when adolescents viewed Black (relative to White) faces. In other words, adolescents with lower subjective social status showed greater activity in neural regions involved in processing salience, perceptual expertise, and thinking about the minds of others when they viewed images of Black faces, suggesting enhanced salience of race for these youth. There was no relationship between objective SES and neural responses to the faces. Moreover, instructing participants to focus on the gender or emotion expression on the face attenuated the relationship between subjective social status and neural processing of race. Together, these results demonstrate that subjective social status shapes the way the brain responds to race, which may have implications for psychopathology.

Adolescence is a developmental period characterized by profound biological, neural, and social changes that have important implications for mental and physical health. The important changes that occur during this time period have led some to conclude that adolescence may be a sensitive period for sociocultural processing (Blakemore & Mills, 2014; Choudhury, 2009). One element of sociocultural development that becomes increasingly important during adolescence is awareness of and attention to social hierarchies. As youth enter adolescence and begin to form more sophisticated social relationships and engage in more social comparison, feelings about one's standing in the social structure of society are brought to the fore and likely play an important role in influencing the ways in which adolescents navigate their increasingly complex social worlds (O'Brien & Bierman, 1988). This could include awareness of one's objective socioeconomic circumstances (e.g., family wealth, parent education level, and occupational prestige; objective socioeconomic status [SES]) as well as more subjective feelings about one's standing in society relative to others (i.e., subjective social status; Goodman et al., 2000, 2001). However, to date relatively little is known about how social status in adolescents influences the ways in which they respond to social information. The present study was designed to investigate how subjective social status and objective SES in adolescents influence neural responses to one particularly important aspect of social information: namely, racial group membership. We explore this question in a sample of Latina/o adolescents, given that this ethnic group is largely underrepresented in developmental/social neuroscience, and given the important role that skin tone/race plays in Latina/o culture (Telzer & Garcia, 2009; Uhlmann, Dasgupta, Elgueta, Greenwald, & Swanson, 2002).

Understanding how social status influences race processing (i.e., quick, largely automatic neural responses to faces of different races) may be particularly important in adolescence, as racial and ethnic identity become particularly salient during this period of development (French, Seidman, Allen, & Aber, 2006; Rivas-Drake et al., 2014; Roberts et al., 1999) as youth start to see and organize individuals according to their race (i.e., racial salience; Pauker, Ambady, & Apfelbaum, 2010). Past research has shown that while younger children form and understand concepts of race and ethnicity mostly based on their literal meanings (e.g., some people have darker skin than others), adolescents have much more

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abstract and complex notions of race and ethnicity (Quintana, 1994) and are more aware of racial stereotypes and norms (Apfelbaum, Pauker, Ambady, Sommers, & Norton, 2008). Preliminary neuroimaging research suggests that greater amygdala reactivity to Black faces compared to White faces may emerge during adolescence (Telzer, Humphreys, Shapiro, & Tottenham, 2013), consistent with what is seen in adults (Lieberman, Hariri, Jarcho, Eisenberger, & Bookheimer, 2005). Given that the amygdala plays a key role in responding to stimuli that are motivationally salient in the environment (Cunningham & Brosch, 2012), these functional magnetic resonance imaging (fMRI) data are consistent with the notion that race and racial identity become particularly salient in adolescence. Further, naturalistic peer group diversity (operationalized as parents' reports of the racial makeup of a child's school and friend group; Telzer et al., 2013) and being part of a mixed-race team (Guassi Moreira, Van Bavel, & Telzer, 2017) modulates the extent of amygdala reactivity to Black (vs. White) faces across development, suggesting that individual differences in experience play an important role in influencing neural responses to race. Thus, given the heightened salience of race/ethnicity and social status in adolescence, understanding how social status may influence neural processing of race-related information during this important period of identity development is especially important.

Very little research in either adolescent or adult samples has examined how subjective social status influences racial salience and race processing despite presumed links between the two (Goodwin, Operario, & Fiske, 1998). In one illuminating study of the effects of social status on both self-reported race and other-rated race among youth, those from lower objective SES backgrounds were more likely to self-identify as Black (compared to White) and were more likely to be rated as Black by an interviewer, compared to higher SES youth, who were more likely to identify as and be identified as White (Penner & Saperstein, 2008). This work has been confirmed by experimental research showing that images of individuals who are "racially ambiguous" (i.e., morphs of Black and White faces) are more likely to be categorized as Black when they are paired with low-status attire (e.g., janitor's uniform), while equally ambiguous faces are more likely to be categorized as White when paired with high-status attire (e.g., business suit; Freeman, Penner, Saperstein, Scheutz, & Ambady, 2011). Further, recent experimental work has shown that greater perceptions of economic scarcity cause individuals to view Black faces as more black than during conditions of economic abundance (Krosch & Amodio, 2014). Taken together, this work suggests the possibility of important links between social status and race, such that information about an individual's social status and the broader economic climate in which they are embedded informs perceptions of their race. However, to date, no known work has examined how a perceiver's social status (i.e., individual differences in social status) influences the way he or she responds to individuals from different racial groups, and no neuroimaging research has explored how social status modulates neural responses to race.

Although no past research has examined how social status influences neural processing of race, the neural systems involved in encoding race-related information are relatively well established (Amodio, 2014; Cikara & Van Bavel, 2014; Eberhardt, 2005; Kubota, Banaji, & Phelps, 2012). Two regions in particular appear to play an important role in the automatic, bottom-up processing of race: the amygdala, a region involved in responding to the salience of environmental cues (Cunningham & Brosch, 2012), and the fusiform face area (FFA), a region involved in processing stimuli about which one has a large amount of expertise (Bukach, Gauthier, & Tarr, 2006), especially faces (Kanwisher & Yovel, 2006). In the context of race processing, greater amygdala activity is often observed during the processing of Black (compared to White) faces (Kubota et al., 2012), which is interpreted as reflecting the greater emotional salience of Black faces, acquired over late childhood and early adolescence as stereotype consciousness, or awareness of broadly held stereotypes of African Americans, develops (McKown & Weinstein, 2003). In contrast, greater FFA activity is often observed during the processing of in-group members relative to out-group members (Golby, Gabrieli, Chiao, & Eberhardt, 2001; Van Bavel, Packer, & Cunningham, 2011), thought to indicate greater expertise for and more enhanced processing of in-group faces. While other areas are also found during race processing, especially when White participants view images of Black faces (e.g., the anterior cingulate cortex and dorsolateral prefrontal cortex), these regions are thought to reflect more higher order cognitive function, including monitoring for potential race bias (i.e., the anterior cingulate cortex) and regulating racial bias when it occurs (i.e., the dorsolateral prefrontal cortex; Kubota et al., 2012). As such, most work indicates that amygdala and FFA are particularly critical for quick, automatic processing of race.

While no studies have investigated how subjective social status influences reactivity in these neural regions that respond to race, some prior work has shown that social status does influence the way in which the brain responds to social information (Mattan, Kubota, & Cloutier, 2017). For example, studies have shown that young adults who rank themselves lower in subjective social status show greater activity in neural regions involved in mentalizing, or thinking about the minds of others, when processing social information, compared to those higher in status (Muscatell et al., 2012, 2016). Further, adolescents from lower objective SES families show greater activity in the dorsomedial prefrontal cortex (DMPFC), a core node of the mentalizing network, and the amygdala, a key region involved in processing the motivational-salience of stimuli in the environment, when viewing images of angry faces (Muscatell et al., 2012). Thus, subjective social status does appear to influence neural responses to social information, though to date, the relationship between subjective social status and neural responses to race is largely unexplored.

Finally, although both behavioral and neuroimaging work suggests that race is encoded relatively quickly and automatically (Blair, Judd, & Fallman, 2004; Ito & Urland, 2003), additional research has shown that instructing individuals to focus on other features of an individual may diminish the salience of race (Blair, 2002). For instance, automatic activation of racial stereotypes is diminished when participants are asked to attend to gender or occupation rather than race (Mitchell, Nosek, & Banaji, 2003), and racial prejudice is reduced when African Americans are labeled as part of an in-group (i.e., attending the same university as the participant; Scroggins, Mackie, Allen, & Sherman, 2016). Similarly, the amygdala response to Black faces is diminished when participants view famous, positively regarded African Americans (Phelps et al., 2000), and when African Americans are labeled as part of an in-group (Van Bavel, Packer, & Cunningham, 2008). Together, these behavioral and fMRI studies suggest that automatic attention to race can be diminished by attending to other features of racial out-group members.

Simultaneously, other research has shown that labeling the emotions on a face or the gender of the individual can lead to reductions in amygdala activity compared to when individuals simply observe emotional facial expressions (Lieberman et al., 2007), again suggesting that labeling salient features of stimuli (e.g., emotion expressions) may disrupt amygdala activity typically associated with processing of affectively laden stimuli. Taken together, this body of work suggests the possibility that attending to other characteristics besides race may disrupt automatic neural processing of race-related information. As such, we sought to examine if directing adolescents' attention toward features other than race (e.g., gender or emotion expression) would change patterns of neural activity observed when they simply observed faces of individuals from different racial groups.

The Present Study

Thus, in the current study, we examined how social status influences neural reactivity to race processing in adolescents. Specifically, we explored three primary research questions: (a) does objective SES influence neural responses to images of Black and White faces; (b) does subjective social status influence neural responses to images of Black and White faces; and (c) does instructing individuals to attend to other features of faces (e.g., gender or affect) attenuate the link between social status and neural processing of race? To investigate these questions, we recruited a sample of Mexican American adolescents to participate in an fMRI study. Mexican Americans were selected as our sample of interest due to the important role that skin tone serves within Latina/o populations (Hunter, 2007). Latina/o individuals are commonly distinguished as either "Blancos" (i.e., having a lighter complexion) or "Morenos" (i.e., having a darker complexion). As such, they are likely to be acutely aware of racial dynamics between darker skinned (i.e., Black) and lighter skinned (i.e., White) individuals (Alba, Jiménez, & Marrow, 2014; Golash-Boza & Darity, 2008). Further, focusing on a Latina/o sample allowed us to move beyond previous neuroimaging research on race processing that has almost exclusively examined neural responses to racial in-group members compared to out-group members, largely in White samples (Amodio, 2014). In the case of our Mexican American sample, both Black and White faces are likely to be perceived as racial out-group members, as no participants in the sample self-identified their race as White or Black. As such, this approach allows us to examine how social status influences neural responses to different racial out-groups that vary in their position within the social dynamics of US culture.

This study utilizes a developmental cultural neuroscience approach (Qu & Telzer, 2017), an emerging interdisciplinary field within cultural and biology interplay (Causadias, Telzer, & Lee, 2017) that investigates the development of cultural processes using neuroimaging methods. This approach provides an important perspective on how culture influences adolescents' adjustment, broadening our understanding of cultural transmission and neural plasticity (Qu & Telzer, 2017). This approach also highlights how sociocultural contexts (e.g., SES and perceived social hierarchies) shape adolescents' neural processing of culturally based information (e.g., race perception), which has implications for cultural differences in youths' adjustment.

Method

Participants

Twenty-three Mexican-origin adolescents (15 females; mean age = 17.22 years, *SD* = 0.60) from the Los Angeles metropolitan area participated in the study. Participants were recruited from a larger longitudinal study, in which inclusion criteria included being of Mexican origin. All participants were from the same Los Angeles high school and were in the 11th or 12th grade and residing at home with their family at the time of the study. The student body of the school was predominantly Latin American, from lower class to lower middle class families, and over 70% of students qualified for free or reduced meals (California Department of Education, 2011).

The majority of adolescents in the present sample were from immigrant families: 4 (17.4%) were of the first generation (i.e., adolescent and parents were born in Mexico), 18 (78.3%) were of the second generation (i.e., adolescent born in the United States but at least one parent was born in Mexico), and 1 (4.3%) was of third generation or greater (i.e., both the adolescent and parents were born in the United States). See Table 1 for additional socioeconomic and family composition information.

There were no exclusion criteria based on language, and all but 1 adolescent completed the measures and scan session in English. One adolescent and 21 parents completed the measures in Spanish, which were translated and then back-translated from English to Spanish by bilingual speakers. Standard exclusion criteria were implemented for the scan, including any MRI contraindications (i.e., claustrophobia or

Table 1. *Socioeconomic characteristics of sample*

Variable	*N* (Percent of sample)
Primary caregiver's highest education	
Did not complete high school	19 (82.6)
Completed high school	1 (4.3)
Completed some college	2 (8.7)
Completed 2-year college	1 (4.3)
Completed 4-year college	0 (0.0)
Primary caregiver's employment	
Currently employed	17 (73.9)
Unskilled	6 (26.1)
Semiskilled	9 (39.1)
Skilled	1 (4.3)
Semiprofessional	1 (4.3)
Professional	0 (0.0)
Secondary caregiver's highest education	
Did not complete high school	16 (69.6)
Completed high school	0 (0.0)
Completed some college	1 (4.3)
Completed 2-year college	1 (4.3)
Completed 4-year college	3 (13.0)
Secondary caregiver's employment	
Currently employed	12 (52.2)
Unskilled	3 (13.0)
Semiskilled	4 (17.4)
Skilled	4 (17.4)
Semiprofessional	1 (4.3)
Professional	0 (0.0)
Parents' marital status	
Married	13 (56.5)
Separated or divorced	3 (13.0)
Never married	4 (17.4)
Widowed	3 (13.0)
Dual-parent household	18 (82)

Note: Marital status refers to the primary caregiver's marital status to the biological parent of the child participant. Columns that do not add to 100% indicate missing responses. Dual-parent household represents whether there are at least two adults in the home. Of the 18 dual-parent households, 11 had more than two adults residing in the home.

presence of ferromagnetic implants in the body). Participants were paid for their participation. Participants and their parents completed written consent and assent in accordance with the University of California at Los Angeles's institutional review board.

Self-report measures

Subjective social status. To measure subjective social status, we used the MacArthur Scale of Subjective Social Status (Adler, Epel, Castellazzo, & Ickovics, 2000), which asks participants to rate themselves on a 12-point scale along dimensions of monetary wealth, education, and job status. Participants were presented with a ladder and asked to choose the rung that they felt represented where they stood compared to others in the United States, where the top rung represents those with the most wealth and education and the best jobs, and the bottom rung represents those with the least wealth and education and the worst jobs. Higher scores indicate higher subjective social status whereas lower scores indicate lower subjective social status. This measure showed skewness of 0.81 and kurtosis of 1.1 in the present sample.

Objective social status. We examined objective social status by measuring parents' SES and economic strain, each of which were reported by the adolescent's primary caregiver.

SES. The primary caregiver each reported his or her own and his or her child's secondary caregiver's (if applicable; usually the father) highest level of education by responding to a scale that ranged from "elementary/junior high school," "some high school," "graduated from high school," "some college," "graduated from college," to "law, medical, or graduate school." The primary caregiver also reported his or her own and his or her child's secondary caregiver's occupation, which was then coded according to a 5-point scale used in previous studies with a similar population (Telzer & Fuligni, 2009) ranging from 1 (*unskilled level*) to 5 (*professional level*). Examples of unskilled worker included such occupations as furniture mover, gas station attendant, food service worker, and housecleaner; semiskilled worker included baker, cashier, landscaper, and security guard; skilled worker included appraiser, barber, seamstress, and electrician; semiprofessional worker included nurse, librarian, optometrist, and office manager; and professional worker included architect, dentist, computer consultant, and physician. If the participant indicated a parent was unemployed, occupational status was not coded. SES was calculated by standardizing and averaging mother's and father's (if applicable) education and occupation. This measure showed a skewness of 1.40 and kurtosis of 1.71 in this sample.

Economic strain. The adolescents' primary caregiver completed a measure indicating his or her family's financial well-being with nine items that tapped economic strain over the past 3 months (Conger et al., 2002). The primary caregivers indicated how much difficulty they had paying bills (1 = *no difficulty at all* to 4 = *a great deal of difficulty*), whether they had money left over at the end of each month (1 = *more than enough money left over* to 4 = *very short of money*), and whether they could afford different necessities such as food, medical care, and clothing (1 = *very true* to 4 = *not at all true*). The scale had acceptable internal consistency ($\alpha = 0.87$), and within this sample, showed skewness of –0.82 and kurtosis of –0.02.

fMRI paradigm

Similar to prior studies examining neural correlates of race processing in youth (Telzer et al., 2013), adolescents completed a face observation task (Hariri, Bookheimer, & Mazziotta, 2000; Lieberman et al., 2007). During the task, participants were presented with a target face in the center of the screen. Target faces depicted Black and White individuals expressing a negative emotion (fearful or angry). Four conditions (affect label, gender label, observe, and shape match) were administered across one task run. Each condition was presented in blocks of five trials (5 s each), with a 500-ms fixation between each face. Participants completed two blocks of each condition, one which included only Black faces and one White faces, half of each were male and half female. An instruction screen appeared for 3 s before each block, indicating what condition was next, and a 12-s crosshair fixation/rest separated each block. Blocks were shown in a randomized order. Faces were selected from a standardized set of face stimuli (Tottenham et al., 2009).

During the affect label condition, participants saw a target face in the middle of the screen depicting either a fearful or an angry expression. Participants were instructed to choose one of two label options presented on the screen that best described the facial emotion (e.g., “scared,” “furious,” “angry,” “fearful,” or “worried”). Two affect labels were paired together, one with the target emotion and a second with a different negative emotion. During the gender label condition, participants saw the same target faces as in the affect label condition, but were instructed to match the gender of the face to a name (e.g., “Manuel” or “Maria”). Two names were paired together, one with a male name and one with a female name. Names were selected that were common names in Spanish and English, with the male and female names being similar in terms of number of letters, syllables, and the first letter. During the observe condition, participants were instructed to passively view the target face, and no emotion labels or names were presented. Finally, during the shape match condition, participants saw a trio of shapes and were instructed to select the shape on the bottom that matched the target shape on top. Only the data from the affect label, gender label, and observe conditions are used for this study.

fMRI data acquisition

Imaging data were collected using a 3 Tesla Siemens Trio MRI scanner. The task was presented on a computer screen, which was projected through scanner-compatible goggles. Data acquired during the face observation task consisted of T2*-weighted echoplanar images (slice thickness, 4 mm; 34 slices; repetition time = 2 s; echo time = 30 ms; flip angle = 90 degrees; matrix = 64×64; field of view = 200 mm; voxel size $3 \times 3 \times 4$ mm^3) for blood oxygen level dependent (BOLD) imaging. A T2*weighted, matched-bandwidth, high-resolution, anatomical scan and magnetization-prepared rapid-acquisition gradient echo scan were acquired for registration purposes (repetition time = 2.3 s; echo time = 21 ms; field of view = 256; matrix = 192×192; sagittal plane; slice thickness = 1 mm; 160 slices). The orientation for the matched-bandwith and echoplanar images scans was oblique axial to maximize brain coverage.

fMRI data preprocessing and analysis

Neuroimaging data were preprocessed and analyzed using Statistical Parametric Mapping (SPM8; Wellcome Department of Cognitive Neurology, Institute of Neurology, London, UK). Preprocessing for each participant’s images included spatial realignment to correct for head motion. Images showing more than 2.5 mm or degrees of image-to-image motion or rotation in any direction were removed from analyses. The realigned functional data were coregistered to the high-resolution magnetization-prepared rapid-acquisition gradient echo scan, which was then segmented into cerebrospinal fluid, gray matter, and white matter. The normalization transformation matrix from the segmentation step was then applied to the functional and structural images, thus transforming them into standard stereotactic space as defined by the Montreal Neurological Institute and the International Consortium for Brain Mapping. The normalized functional data were smoothed using an 8-mm Gaussian kernel, full width at half maximum, to increase the signal-to-noise ratio.

Whole-brain statistical analyses were performed using the general linear model in SPM8. Each trial was convolved with the canonical hemodynamic response function. High-pass temporal filtering with a cutoff of 128 s was applied to remove low-frequency drift in the time series. Serial autocorrelations were estimated with a restricted maximum likelihood algorithm with an autoregressive model order of 1. The task was modeled as a block design. The 12-s fixation preceding each block was not modeled and therefore served as the implicit baseline. The following contrasts were computed at the individual level for Black and White faces separately: affect label, gender label, and observe. In addition, shape match was modeled as a separate regressor but not examined further.

The individual subject contrasts were submitted to random-effects, group-level analyses. At the group level, analyses were conducted using GLMFlex (McLaren, Schultz, Locascio, Sperling, & Atri, 2011), which removes outliers and sudden activation changes in the brain, partitions error terms, analyzes all voxels containing data, and corrects for variance–covariance inequality. Whole-brain regression analyses were run to examine how subjective social status correlates with neural activation when viewing Black relative to White faces. Separate analyses examined the conditions of interest (i.e., affect label, gender label, and observe). To correct for multiple comparisons, we conducted a Monte Carlo simulation implemented using 3dClustSim in the software package AFNI (updated version April 2017) and the –acf option in 3dFWHMx to estimate the smoothness. Results of 3dClustSim indicated a voxel-wise threshold of $p < .001$ combined with a minimum cluster size of 26 voxels for the whole brain, corresponding to $p < .05$, false discovery rate corrected.

Results

Behavioral results

We examined the correlations between objective SES indicators (i.e., composite of parent education and occupation; family financial strain) and subjective social status in this sample of adolescents. There was no significant association between subjective social status and the parent education/occupation composite ($r = -.04$, $p = .86$), or with financial strain ($r = -.17$, $p = .44$) in this sample of adolescents. Further, the parent education/occupation composite was not significantly correlated with self-reported economic strain ($r = -.22$, $p = .33$).

fMRI results

Association between subjective social status and neural responses to race. To explore the association between subjective social status and neural responses to race processing, we conducted a whole-brain regression analysis in which we examined neural responses to observing Black faces compared to White faces, and searched for regions that showed an association with subjective social status. Results of this analysis revealed a negative correlation between subjective social status and BOLD signal in the amygdala, hippocampus, and temporal poles bilaterally, left fusiform gyrus (encompassing the FFA), medial prefrontal cortex (BA10), dorsomedial prefrontal cortex (BA9), and left ventrolateral prefrontal cortex (VLPFC; BA 11), among other regions (see Table 2 for a complete list of activations and Figure 1 for scatter plots of the associations). Activation in many of these regions (i.e., amygdala, hippocampus, temporal poles, fusiform, and VLPFC) remained negatively associated with subjective social status after controlling for the objective SES indicators, suggesting that the results are not driven by variability in parental education, occupation, or family economic strain (see Table 2). No activity was positively associated with subjective social status in the contrast of observing Black faces versus White faces.

In an effort to further explore and clarify if the results were driven by individuals lower in subjective social status showing more activity to Black faces or individuals higher in subjective social status showing more activity to White faces, we ran follow-up regression analyses. Specifically, we regressed subjective social status separately onto the contrasts of Black faces compared to baseline, and White faces compared to baseline. For Black faces, we again saw a negative association between subjective social status and BOLD signal in the amygdala, hippocampus, and VLPFC (BA10/BA46; all bilaterally), the left temporal pole, and the left fusiform gyrus, among other regions (see Table 2 for a complete list of activations and Figure 2 for scatter plots of associations). No activity was positively correlated with subjective social status when observing Black faces (vs. baseline). There were no regions that were negatively correlated with subjective social status while observing White faces (vs. baseline). However, a number of regions showed a *positive* correlation when observing White faces (vs. baseline), including the ventromedial prefrontal cortex (BA10), bilateral ventral striatum, and occipital cortex (Table 2 for a complete list of activations and Figure 3 for scatter plots of associations).

Association between objective SES and neural responses to race. Next, we examined if there was a relationship between the objective SES indicators and neural responses to race processing. We explored the associations between SES as measured by the combination of parental education and occupation and neural responses to viewing Black faces compared to White faces. This analysis did not reveal any significant clusters of activity that were either negatively or positively correlated with parental education and occupation. Next, we examined the association between SES as measured by family economic strain and neural responses to viewing Black faces compared to White faces. There were again no significant activations that correlated negatively or positively with SES as conceptualized as economic strain. Thus, it appears that, in this sample, there is no association between more objective indicators of SES (i.e., parent education/occupation; economic strain) and neural responses to observing faces of different races.

Relationship between subjective social status and neural responses to labeling gender and emotion. Finally, we explored if shifting the focus from automatic processing of race in faces (as in the observe condition) to non-race-related information (i.e., labeling gender or emotion) changed the pattern of associations with subjective social status. We examined if there was an association between subjective social status and neural responses to gender labeling for Black faces versus White faces. No significant activations were either positively or negatively correlated with subjective social status when the task was shifted to labeling gender rather than passively observing the faces. A similar pattern emerged when we examined the association between subjective social status and neural responses to emotion labeling for Black versus White faces: again, there was no association (in either a negative or a positive direction) between subjective social status and activity in response to labeling the emotion on faces of different races. Finally, we examined the relationship between subjective social status and neural responses to labeling the emotions on Black faces compared to simply observing Black faces. This comparison again revealed that there was no significant association between subjective social status and neural responses to labeling the emotions on Black faces (compared to just observing Black faces). Taken together, these results suggest that instructing adolescents to focus on features of the face besides race (i.e., those that signal gender or emotion) eliminates the associations between subjective social status and neural responses to different races.

Discussion

Adolescence is a sensitive period for sociocultural development (Blakemore & Mills, 2014), wherein different facets of social identity, including perceptions of social status in society and racial/ethnic identity, become particularly salient (Apfelbaum et al., 2008; French et al., 2006; Roberts et al., 1999; Rowley, Kurtz-Costes, Mistry, & Faegans, 2007). While research in adults has begun to focus on how social status influences social information processing (Mattan et al.,

Table 2. *Neural regions showing significant associations with subjective social status*

Anatomical region	+/–	BA	*x*	*y*	*z*	*t*	*k*
Black observe > White observe							
R cerebellum[a]*	–		−49	−38	−38	−6.65	3445
L cerebellum*[a]	–		−33	−64	−35	−4.89	
Medial cerebellum[a]	–		0	−46	−38	−5.83	
L fusiform*[a]	–		−33	−67	−14	−4.93	
R fusiform[a]	–		48	−70	−23	−5.02	
L brainstem*[a]	–		–9	−13	−14	−5.12	
R brainstem*[a]	–		12	−16	−17	−5.91	
L hippocampus*[a]	–		−24	–7	−20	−4.88	
R hippocampus*[a]	–		27	−19	−14	−5.66	
L putamen*[a]	–		−27	2	–5	−4.03	
R putamen*[a]	–		24	–1	–5	−5.44	
L amygdala*[a]	–		−24	–7	−20	−4.88	
R amygdala*[a]	–		24	–1	−20	−4.05	
mPFC	–		0	59	4	−4.44	57
R MFG*	–		42	44	13	−4.81	50
L VLPFC*	–		−18	56	–8	−4.69	45
L SFG	–		−30	41	43	−4.21	44
Black observe > baseline							
R calcarine gyrus[b]	–		18	−79	13	6.59	1820
L dorsal cerebellum[b]	–		−24	−67	−26	6.30	
L ventral cerebellum[b]	–		−24	−73	−44	6.28	
L dorsal cerebellum[b]	–		18	−67	−44	4.82	
R ventral cerebellum[b]	–		3	−61	−50	5.43	
R hippocampus[c]	–		27	−10	−20	6.09	905
L hippocampus[c]	–		−27	−10	−20	5.31	
Pons[c]	–		9	−25	−20	5.36	
R amygdala[c]	–		27	–4	−20	4.91	
L amygdala[c]	–		−27	–4	−20	4.64	
Mid-cingulate	–		−15	17	34	4.80	60
L MFG	–		−30	53	22	4.41	49
R MFG	–		39	41	13	4.47	29
Posterior SFG	–		−15	17	67	5.84	29
White observe > baseline							
R calcarine gyrus	+		21	−88	7	−7.86	126
L IOG	+		−21	−97	–5	−4.95	50
L MOG	+		−21	−94	10	−4.45	27
L FFA	+		−42	−64	−20	−5.87	55
Mid-cingulate	+		–9	5	28	−5.76	48
R VS	+		12	5	–2	−5.35	52
R thalamus	+		12	−19	13	−5.30	104
L VS	+		−18	17	–2	−5.29	98
L thalamus	+		−24	−22	13	−4.59	191
L vmPFC	+		–9	59	−14	−5.29	50
R aMPFC	+		9	65	–2	−5.18	46

Note: Parametric map thresholded at $p < .001$, with a minimum cluster size $k = 26$. L and R refer to left and right hemispheres; + and – refer to positive or negative association with subjective social status; BA refers to Brodmann Area of peak voxel; k refers to the number of voxels in each significant cluster; t refers to peak activation level in each cluster; x, y, and z refer to MNI coordinates; voxel size = 3 mm^3. Superscripts (e.g., a, b, etc.) indicate that peak voxels are part of a contiguous cluster; * indicates regions that survive controlling for objective socioeconomic status, which is only investigated in the Black observe versus White observe contrast. mPFC, medial prefrontal cortex. MFG, middle frontal gyrus, VLPFC, ventrolateral prefrontal cortex. SFG, superior frontal gyrus. IOG, inferior occipital gyrus. MOG, middle occipital gyrus. FFA, fusiform face area. VS, ventral striatum. vmPFC, ventromedial prefrontal cortex. aMPFC, anterior medial prefrontal cortex.

2017), much less work has focused on understanding the relationship between social status and neural responses to social information in adolescents, and no known studies have examined how social status (in either adolescents or adults) influences neural processing of race, one particularly important facet of social identity. To help fill this gap in our knowledge, we present the first known data to explore how individual differences in subjective social status influence neural responses during race perception. Specifically, we used fMRI to index Mexican American adolescents' neural responses to Black and White faces, both while they passively observed the faces, and while they attended to specific features of the

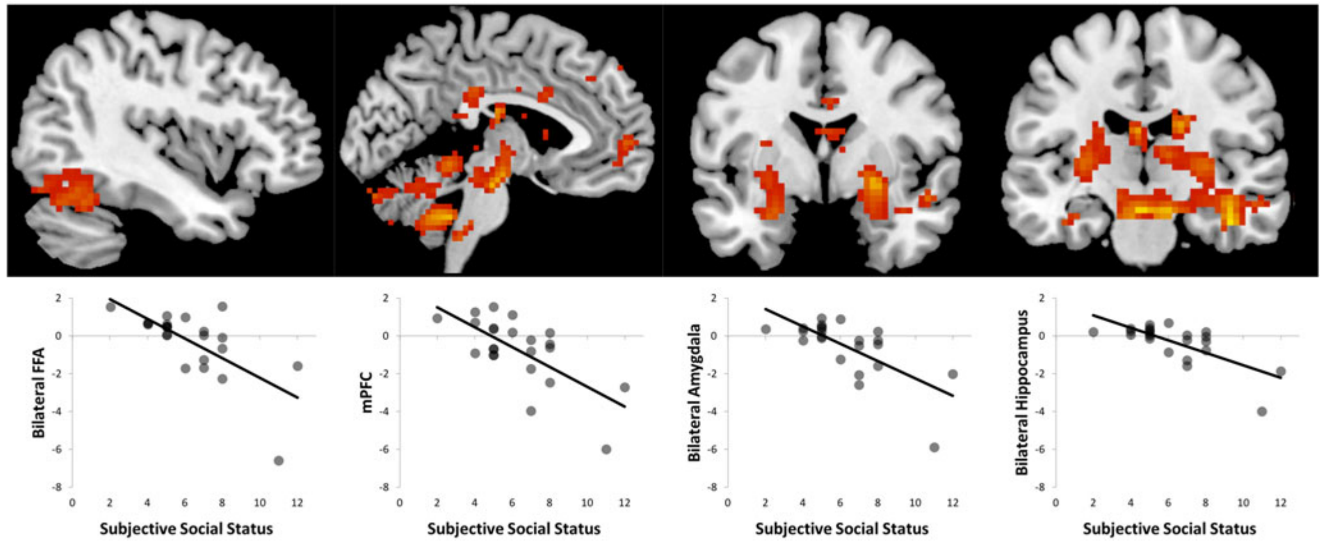

Figure 1. Negative association between subjective social status and neural responses to observing Black faces versus observing White faces.

face unrelated to race (e.g., gender or emotion expression). Results indicated that adolescents lower in subjective social status showed greater activity in neural regions known to respond quickly and automatically to stimuli with motivational salience (including race; e.g., the amygdala) and to stimuli with which one has expertise (e.g., the FFA), specifically when viewing images of Black faces (relative to White faces or baseline). No such pattern emerged for higher subjective status adolescents; if anything, these individuals showed greater neural responses to White faces (relative to baseline). Instructing adolescents to focus on features of the stimuli other than race attenuated the association between subjective social status and enhanced neural activity in salience-related regions in response to Black faces. Together, this pattern of results suggests that youth with lower subjective social status may be more automatically attentive to race, specifically to the race of other groups with lower social standing in society (i.e., African Americans). Below, we provide more extensive discussion of these results and their potential implications for psychopathology.

In exploring the association between social status and neural responses to Black (vs. White) faces, we found a negative association between subjective social status and neural activity in a number of regions, including a large cluster of activation in the medial temporal lobe, extending from the amygdala through the hippocampus to the putamen. We also found evidence for a negative association between subjective social status and activity in the FFA, an area important for face processing and responding to stimuli about which one has a high level of expertise. These two regions (i.e., the amygdala and FFA) are observed in many fMRI studies of race processing, with the amygdala often found to be more active in response to Black faces (regardless of the race of the participant; Kubota et al., 2012; Lieberman et al., 2005) and the FFA more active in response to in-group members, likely reflecting deeper perceptual processing of the faces of in-group members (Van Bavel et al., 2008, 2011). In light of this past research, one interpretation of the present findings is that race may be more salient for adolescents who perceive themselves as lower in social status, and they may engage in deeper perceptual processing of race. Further, though speculative, it is possible that Latina/o adolescents with lower subjective social status may see African Americans as more a part of their in-group, perhaps due to the fact that African Americans are also often seen as a group with lower social standing in society. However, in light

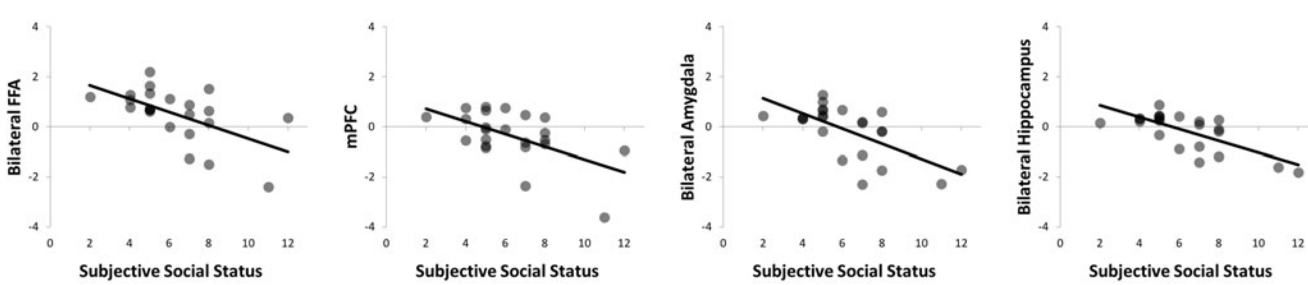

Figure 2. Negative association between subjective social status and neural responses to observing Black faces versus baseline.

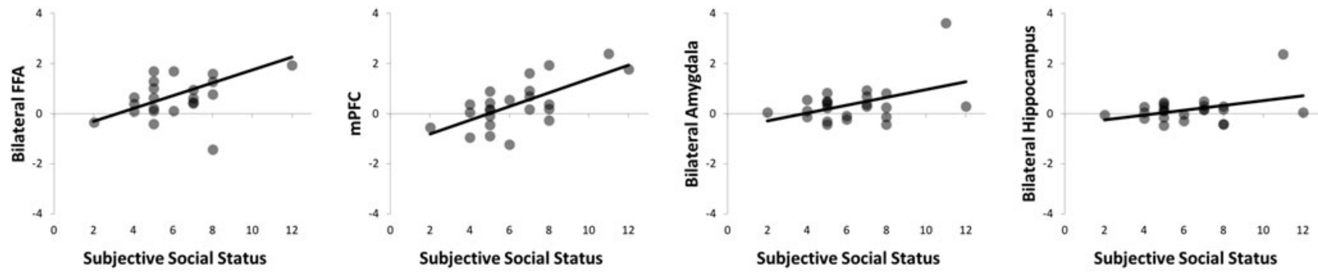

Figure 3. Positive association between subjective social status and neural responses to observing White faces versus baseline.

of the fact that we do not have behavioral or self-report data to substantiate this interpretation of the neural data, these conclusions are presented with caution. More research examining how subjective social status influences perceptions of race (in both adolescent and adult samples) is needed to fully unpack the relationship between social status and race processing. Further, meta-analyses of the neural systems involved in processing race (in both adult and adolescent samples) that attempt to quantify the consistency (or lack thereof) in the spatial patterns of activation and magnitude of association between neural responses to faces of different races (i.e., Black individuals and White individuals) are needed to help move this area of work forward.

Beyond the medial temporal lobe (i.e., the amygdala) and FFA activity discussed above, we also found a negative association between subjective social status and activity in the DMPFC and more ventral aspects of the medial prefrontal cortex (MPFC), as well as lateral portions of the prefrontal cortex (the left VLPFC) in response to Black (vs. White) faces. We saw a *positive* association between subjective social status and activity in the MPFC and DMPFC in response to White faces (vs. baseline), such that individuals who rated themselves higher in subjective social status showed greater activity in these regions when viewing White faces. Given that the DMPFC and MPFC are often active during tasks that involve thinking about the mental states of others (Adolphs, 2009; Frith, 2007), it may be the case that lower subjective status individuals are more likely to automatically think about the minds of individuals from lower status groups (i.e., African Americans), while higher subjective status individuals may focus more on individuals from high-status groups (i.e., Whites). This is consistent with past research demonstrating that individuals who rate themselves as lower in subjective social status are more likely to activate regions involved in thinking about others, or mentalizing, when processing social information (Muscatell et al., 2012, 2016), as well as other work showing that individuals who are lower in social standing respond to both high- and low-status others, while individuals higher in social standing respond only to other higher status individuals (Zerubavel, Bearman, Weber, & Ochsner, 2015). Here, we extend this prior work to show that subjective social status also influences neural processing of race, suggesting that individuals who are lower in perceived social status may be especially attentive to the minds of individuals from lower status racial groups (e.g., African Americans), while higher subjective status individuals may selectively focus on the minds of people from higher status groups (e.g., Whites).

We found also that instructing adolescents to focus on characteristics of individuals other than race disrupted the association between subjective social status and neural processing of race. More specifically, when participants were asked to label either the gender of the person pictured or the emotion expression on the person's face (i.e., rather than just passively viewing the faces), we no longer saw associations between subjective social status and neural activity in any region. This pattern is consistent with other research showing that drawing attention to features of individuals besides race disrupts stereotypes (Mitchell et al., 2003) and reduces amygdala activation (Phelps et al., 2000). Thus, while adolescents with lower subjective social status may automatically process race as a more salient feature of identity than higher subjective status adolescents, these responses are malleable and can be diminished if individuals focus on characteristics besides race.

It is interesting to note that while other studies in adults have found a significant, positive association between subjective social status ratings and more objective indicators of SES (e.g., income, education, and occupation; Adler et al., 2000), subjective status ratings and objective SES indicators were not correlated in this sample of Mexican American adolescents. This could be due to a lack of statistical power to detect the association (due to a small sample size), and/or a restricted range of scores on the objective SES measures. However, this lack of correlation between objective SES indicators and subjective social status may also be meaningful, as it has also been observed in other studies of adolescents (Goodman et al., 2000), including those in predominantly low-income, Mexican communities (Ritterman et al., 2009), suggesting that adolescents may be using information other than objective SES to rate their subjective social standing. This may be especially true among adolescents from racial/ethnic minority groups, as associations between objective and subjective SES indicators may be weaker in these populations compared to the associations observed in White-majority groups (Cundiff & Matthews, 2017). Further, recent research has pointed to the critical role that relative deprivation and economic inequality (rather than objective indicators of SES) play in influencing important outcomes (Luttmer, 2005; Payne, Brown-Iannuzzi, & Hannay, 2017), suggesting that one's perception of their economic standing *relative to others* is particularly important. Further, the fact that subjective social status was related to neural processing of race whereas objective SES measures were not points to the utility of using subjective measures to index social status, perhaps particularly within samples that are relatively homogenous in their objective SES, such as the sample employed here.

In sum, results from the present study highlight the important role that individual differences in adolescents' perceptions of their social status play in influencing the way the brain responds to race. While we did not directly measure symptoms of psychopathology in this sample, it will be important for future research to examine if the relationship between social status and race processing influences mental health in youth. For example, other research has shown that perceptions of one's family's social standing are associated with risk for depression in adolescence, such that individuals who perceive themselves as lower in social status exhibit greater depressive symptoms than those who rate themselves higher in status (Åslund, Leppert, Starrin, & Nilsson, 2009). Further, greater activation in the amygdala and the DMPFC during social interactions, two regions that were associated with subjective social status in the present study, has been associated with physiological responses that may, over time, lead to the development of negative mental health outcomes (Muscatell et al., 2015, 2016; Muscatell & Eisenberger, 2012). In other words, the tendency of individuals with lower subjective social status to engage neural systems involved in processing social information may lead to increased physiological activation that could ultimately contribute to the development of psychopathology (Manczak, Basu, & Chen, 2016; Manczak, DeLongis, & Chen, 2016). It will be important for future work in this area to examine how the heightened salience of race (and corresponding neural activation) among lower status individuals may be linked to mental health.

It is also important to consider how the findings presented here fit within the cultural development and psychopathology framework (Causadias, 2013) and the area of culture-biology interplay more broadly (Causadias et al., 2017), and can be used to inform future work moving forward. With regard to cultural development and psychopathology, results from the current study point to the utility in considering how, within a group of individuals from one ethnic background (i.e., Latina/Latinos), variability in individual-level self-perceptions (i.e., subjective social status) can influence neural responding to social information, particularly, race processing. This approach highlights the need to consider both how group-level factors like ethnicity and culture interact with individual-level perceptions to contribute to intergroup relations (Causadias, 2013). Further, the results presented here are consistent with a developmental cultural neuroscience perspective (Qu & Telzer, 2017) that emphasizes the important ways in which culture can shape neural plasticity across development. More specifically, we show that a broad societal construct (i.e., subjective social status) varies among individuals from a similar ethnic background and influences neural responsivity. It will be important for future work in this area to examine how culture influences development of neural processing of race over time (emphasizing cultural, developmental, and neural plasticity), and to explore how the development of trajectories of patterns of neural responding may confer both risk and resilience among youth. It will also be critical for future studies to explore the role of racial/ethnic identity development (Umaña-Taylor et al., 2014) and its socialization by parents in influencing neural responses to different racial groups. Under a developmental cultural neuroscience approach, it is possible that racial and ethnic identity development may influence the way the brain responds to faces of different races, in ways that may contribute to both risk and resilience for psychopathology among those from different cultural, racial, and ethnic backgrounds. This idea is largely unexplored in neuroimaging research to date and is an important direction moving forward.

Results from the present study should be interpreted in light of some important limitations. First and foremost, like many neuroimaging studies, the sample size is relatively small, particularly for examining individual differences and associations between self-report measures (e.g., subjective social status and objective SES). Future research with larger samples that attempts to replicate the effects reported here is critical. Second, all participants in the present sample were Mexican American, and thus it is not clear if the results extend to individuals from other racial and ethnic groups, or to other Latina/o groups (e.g., individuals from other Central or South American countries). However, given the underrepresentation of Mexican Americans in neuroimaging research, our results are an important step in broadening the developmental and social neuroscience literature to include non-White samples. Further, while we selected a Latina/o sample due to the enhanced salience of skin color in this group, we unfortunately do not know if perceptions of subjective social status track with skin color (i.e., "Blancos" or lighter skinned individuals having higher status compared to "Morenos" or darker skinned individuals having lower social status) in this specific sample of Latina/o youth, as has been reported in other samples (Telzer & Garcia, 2009; Uhlmann et al., 2002). Along similar lines, all faces used as stimuli in this study depicted Black or White individuals, which limits the knowledge that can be gained from these stimuli. It will be important for future work to investigate neural responses to brown and multiracial faces to explore if a similar (or different) pattern may occur. A third limitation is that the names used in the gender-labeling version of the fMRI task have not been normed for the extent to which they likely describe one gender face versus another. As such, future studies utilizing these stimuli could provide important validation data on these names. Fourth and finally, due to the nature of the fMRI task employed here, we do not know if the observed neural responses translate into differences in behavior toward different racial groups (e.g., implicit attitudes toward Black and White Americans). It will be important for future work to explore if the enhanced neural processing of race for lower status individuals is associated with biases (or lack thereof) toward these groups.

In conclusion, we report results from the first known study to examine how subjective social status influences neural processing of race. We focused on adolescents, given that both social status and racial/ethnic identity are particularly salient during this important developmental period. Our results show that individuals who perceive themselves as having lower social status in society show greater activity in neural regions involved in processing salience (i.e., the amygdala), expertise and deeper perceptual encoding of faces (i.e., the FFA), and in thinking about the minds of others (i.e., the DMPFC and MPFC) when viewing Black faces relative to White faces. This association is attenuated when individuals are asked to focus on features of faces other than race, including gender and emotion expression. These findings are important for advancing our knowledge of how social status influences the way in which the brain responds to social information, and future research should explore if this enhanced processing of race is related to mental health outcomes.

References

Adler, N. E., Epel, E. S., Castellazzo, G., & Ickovics, J. R. (2000). Relationship of subjective and objective social status with psychological and physiological functioning: Preliminary data in healthy white women. *Health Psychology*, *19*, 586–592. doi:10.1037//0278-6133.19.6.586

Adolphs, R. (2009). The social brain: Neural basis of social knowledge. *Annual Review of Psychology*, *60*, 693–716. doi:10.1146/annurev.psych.60.110707.163514

Alba, R., Jiménez, T. R., & Marrow, H. B. (2014). Mexican Americans as a paradigm for contemporary intra-group heterogeneity. *Ethnic and Racial Studies*, *37*, 446–466. doi:10.1080/01419870.2013.786111

Amodio, D. M. (2014). The neuroscience of prejudice and stereotyping. *Nature Reviews Neuroscience*, *15*, 670–682. doi:10.1038/nrn3800

Apfelbaum, E. P., Pauker, K., Ambady, N., Sommers, S. R., & Norton, M. I. (2008). Learning (not) to talk about race: When older children underperform in social categorization. *Developmental Psychology*, *44*, 1513–1518. doi:10.1037/a0012835

Åslund, C., Leppert, J., Starrin, B., & Nilsson, K. W. (2009). Subjective social status and shaming experiences in relation to adolescent depression. *Archives of Pediatrics and Adolescent Medicine*, *163*, 55–60. doi:10.1001/archpedi.163.1.55

Blair, I. V. (2002). The malleability of automatic stereotypes and prejudice. *Personality and Social Psychology Review*, *6*, 242–261. doi:10.1207/S15327957PSPR0603

Blair, I. V., Judd, C. M., & Fallman, J. L. (2004). The automaticity of race and afrocentric facial features in social judgments. *Journal of Personality and Social Psychology*, *87*, 763–778. doi:10.1037/0022-3514.87.6.763

Blakemore, S.-J., & Mills, K. L. (2014). Is adolescence a sensitive period for sociocultural processing? *Annual Review of Psychology*, *65*, 187–207. doi:10.1146/annurev-psych-010213-115202

Bukach, C. M., Gauthier, I., & Tarr, M. J. (2006). Beyond faces and modularity: The power of an expertise framework. *Trends in Cognitive Sciences*, *10*, 159–166. doi:10.1016/j.tics.2006.02.004

Causadias, J. M. (2013). A roadmap for the integration of culture into developmental psychopathology. *Development and Psychopathology*, *25*, 1375–1398. doi:10.1017/S0954579413000679

Causadias, J. M., Telzer, E. H., & Lee, R. M. (2017). Culture and biology interplay: An introduction. *Cultural Diversity and Ethnic Minority Psychology*, *23*, 1–4. doi:10.1037/cdp0000121

Choudhury, S. (2009). Culturing the adolescent brain: What can neuroscience learn from anthropology? *Social Cognitive and Affective Neuroscience*, *5*, 159–167. doi:10.1093/scan/nsp030

Cikara, M., & Van Bavel, J. J. (2014). The neuroscience of intergroup relations: An integrative review. *Perspectives on Psychological Science*, *9*, 245–274. doi:10.1177/1745691614527464

Conger, R. D., Wallace, L. E., Sun, Y. M., Simons, R. L., McLoyd, V. C., & Brody, G. H. (2002). Economic pressure in African American families: A replication and extension of the family stress model. *Developmental Psychology*, *38*, 179–193. doi:10.1037//0012-1649.38.2.179

Cundiff, J. M., & Matthews, K. A. (2017). Is subjective social status a unique correlate of physical health? A meta-analysis. *Health Psychology*, *36*, 1109–1125. doi:10.1037/hea0000534

Cunningham, W. A., & Brosch, T. (2012). Motivational salience: Amygdala tuning from traits, needs, values, and goals. *Current Directions in Psychological Science*, *21*, 54–59. doi:10.1177/0963721411430832

Eberhardt, J. L. (2005). Imaging race. *American Psychologist*, *60*, 181–190. doi:10.1037/0003-066X.60.2.181

Freeman, J. B., Penner, A. M., Saperstein, A., Scheutz, M., & Ambady, N. (2011). Looking the part: Social status cues shape race perception. *PLOS ONE*, *6*. doi:10.1371/journal.pone.0025107

French, S. E., Seidman, E., Allen, L., & Aber, J. L. (2006). The development of ethnic identity during adolescence. *Developmental Psychology*, *42*, 1–10. doi:10.1037/0012-1649.42.1.1

Frith, C. D. (2007). The social brain? *Philosophical Transactions of the Royal Society B: Biological Sciences*, *362*, 671–678. doi:10.1098/rstb.2006.2003

Golash-Boza, T., & Darity, W. (2008). Latino racial choices: The effects of skin colour and discrimination on Latinos' and Latinas' racial self-identifications. *Ethnic and Racial Studies*, *31*, 899–934. doi:10.1080/01419870701568858

Golby, A. J., Gabrieli, J. D. E., Chiao, J. Y., & Eberhardt, J. L. (2001). Differential responses in the fusiform region to same-race and other-race faces. *Nature Neuroscience*, *4*, 845–850. doi:10.1038/90565

Goodman, E., Adler, N. E., Kawachi, I., Frazier, A. L., Huang, B., & Colditz, G. A. (2001). Adolescents' perceptions of social status: Development and evaluation of a new indicator. *Pediatrics*, *108*, 1–8. doi:10.1542/peds.108.2.e31

Goodman, E., Amick, B. C., Rezendes, M. O., Levine, S., Kagan, J., Rogers, W. H., & Tarlov, A. R. (2000). Adolescents' understanding of social class: A comparison of white upper middle class and working class youth. *Journal of Adolescent Health*, *27*, 80–83. doi:10.1016/S1054-139X(99)00116-0

Goodwin, S. A., Operario, D., & Fiske, S. T. (1998). Situational power and interpersonal dominance facilitate bias and inequality. *Journal of Social Issues*, *54*, 677–698. doi:10.1111/0022-4537.901998090

Guassi Moreira, J. F., Van Bavel, J. J., & Telzer, E. H. (2017). The neural development of "us and them." *Social Cognitive and Affective Neuroscience*, *12*, 184–196. doi:10.1093/scan/nsw134

Hariri, A. R., Bookheimer, S. Y., & Mazziotta, J. C. (2000). Modulating emotional responses: Effects of a neocortical network on the limbic system. *NeuroReport*, *11*, 43–48. doi:10.1097/00001756-200001170-00009

Hunter, M. (2007). The persistent problem of colorism: Skin tone, status, and inequality. *Sociology Compass*, *1*, 237–254. doi:10.1111/j.1751-9020.2007.00006.x

Ito, T. A., & Urland, G. R. (2003). Race and gender on the brain: Electrocortical measures of attention to the race and gender of multiply categorizable individuals. *Journal of Personality and Social Psychology*, *85*, 616–626. doi:10.1037/0022-3514.85.4.616

Kanwisher, N., & Yovel, G. (2006). The fusiform face area: A cortical region specialized for the perception of faces. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *361*, 2109–2128. doi:10.1098/rstb.2006.1934

Krosch, A. R., & Amodio, D. M. (2014). Economic scarcity alters the perception of race. *Proceedings of the National Academy of Sciences*, *111*, 9079–9084. doi:10.1073/pnas.1404448111

Kubota, J. T., Banaji, M. R., & Phelps, E. A. (2012). The neuroscience of race. *Nature Neuroscience*, *15*, 940–948. doi:10.1038/nn.3136

Lieberman, M. D., Eisenberger, N. I., Crockett, M. J., Tom, S. M., Pfeifer, J. H., & Way, B. M. (2007). Affect labeling disrupts amygdala activity in response to affective stimuli. *Psychological Science*, *18*, 421–428. doi:10.1111/j.1467-9280.2007.01916.x

Lieberman, M. D., Hariri, A., Jarcho, J. M., Eisenberger, N. I., & Bookheimer, S. Y. (2005). An fMRI investigation of race-related amygdala activity in African-American and Caucasian-American individuals. *Nature Neuroscience*, *8*, 720–722. doi:10.1038/nn1465

Luttmer, E. F. P. (2005). Neighbors as negatives: Relative earnings and well-being. *Quarterly Journal of Economics*, *120*, 963–1002. doi:10.1093/qje/120.3.963

Manczak, E. M., Basu, D., & Chen, E. (2016). The price of perspective taking. *Clinical Psychological Science*, *4*, 485–492. doi:10.1177/2167702615595001

Manczak, E. M., DeLongis, A., & Chen, E. (2016). Does empathy have a cost? Diverging psychological and physiological effects within families. *Health Psychology*, *35*, 211–218. doi:10.1037/hea0000281

Mattan, B. D., Kubota, J. T., & Cloutier, J. (2017). How social status shapes person perception and evaluation: A social neuroscience perspective. *Perspectives on Psychological Science*, *12*, 468–507. doi:10.1177/1745691616677828

McKown, C., & Weinstein, R. S. (2003). The development and consequences of stereotype consciousness in middle childhood. *Child Development*, *74*, 498–515. doi:10.1111/1467-8624.7402012

McLaren, D. G., Schultz, A. P., Locascio, J. J., Sperling, R. A., & Atri, A. (2011). *Repeated-measures designs overestimate between-subject effects in fMRI packages using one error term*. Paper presented at the 17th Annual Meeting of Organization for Human Brain Mapping, Quebec City, Canada, June, 26–30, 2011. Retrieved from http://mrtoolsmghharvardedu/indexphp/GLM_Flex

Mitchell, J. P., Nosek, B. A., & Banaji, M. R. (2003). Contextual variations in implicit evaluation. *Journal of Experimental Psychology: General*, *132*, 455–469. doi:10.1037/0096-3445.132.3.455

Muscatell, K. A., Dedovic, K., Slavich, G. M., Jarcho, M. R., Breen, E. C., Bower, J. E., . . . Eisenberger, N. I. (2015). Greater amygdala activity and dorsomedial prefrontal-amygdala coupling are associated with enhanced inflammatory responses to stress. *Brain, Behavior, and Immunity*, *43*. doi:10.1016/j.bbi.2014.06.201

Muscatell, K. A., Dedovic, K., Slavich, G. M., Jarcho, M. R., Breen, E. C., Bower, J. E., . . . Eisenberger, N. I. (2016). Neural mechanisms linking social status and inflammatory responses to social stress. *Social Cognitive and Affective Neuroscience*, *11*, 915–922. doi:10.1093/scan/nsw025

Muscatell, K. A., & Eisenberger, N. I. (2012). A social neuroscience perspective on stress and health. *Social and Personality Psychology Compass*, *6*, 890–904. doi:10.1111/j.1751-9004.2012.00467.x

Muscatell, K. A., Morelli, S. A., Falk, E. B., Way, B. M., Pfeifer, J. H., Galinsky, A. D., . . . Eisenberger, N. I. (2012). Social status modulates neural activity in the mentalizing network. *NeuroImage*, *60*, 1771–1777. doi:10.1016/j.neuroimage.2012.01.080

O'Brien, S. F., & Bierman, K. L. (1988). Conceptions and perceived influence of peer groups: Interviews with preadolescents and adolescents. *Child Development*, *59*, 1360–1365. doi:10.2307/1130498

Pauker, K., Ambady, N., & Apfelbaum, E. P. (2010). Race and salience and essentialist thinking in racial stereotype development. *Child Development*, *81*, 1799–1813. doi:10.1111/j.1467-8624.2010.01511.x

Payne, B. K., Brown-Iannuzzi, J. L., & Hannay, J. W. (2017). Economic inequality increases risk taking. *Proceedings of the National Academy of Sciences*, *114*, 4643–4648. doi:10.1073/pnas.1616453114

Penner, A. M., & Saperstein, A. (2008). How social status shapes race. *Proceedings of the National Academy of Sciences*, *105*, 19628–19630. doi:10.1073/pnas.0805762105

Phelps, E. A., O'Connor, K. J., Cunningham, W. A., Funayama, E. S., Gatenby, J. C., Gore, J. C., & Banaji, M. R. (2000). Performance on indirect measures of race evaluation predicts amygdala activation. *Journal of Cognitive Neuroscience*, *12*, 729–738. doi:10.1162/089892900562552

Qu, Y., & Telzer, E. H. (2017). Developmental cultural neuroscience: Progress and prospect. In J. M. Causadias, E. H. Telzer, & N. Gonzales (Eds.), *The handbook of culture and biology* (pp. 465–587). Hoboken, NJ: Wiley.

Quintana, S. M. (1994). A model of ethnic perspective-taking ability applied to Mexican-American children and youth. *International Journal of Intercultural Relations*, *18*, 419–448. doi:10.1016/0147-1767(94)90016-7

Ritterman, M. L., Fernald, L. C., Ozer, E. J., Adler, N. E., Gutierrez, J. P., & Syme, S. L. (2009). Objective and subjective social class gradients for substance use among Mexican adolescents. *Social Science and Medicine*, *68*, 1843–1851. doi:10.1016/j.socscimed.2009.02.048

Rivas-Drake, D., Seaton, E. K., Markstrom, C., Quintana, S., Syed, M., Lee, R. M., . . . Sellers, R. M. (2014). Ethnic and racial identity in adolescence: Implications for psychosocial, academic, and health outcomes. *Child Development*, *85*, 40–57. doi:10.1111/cdev.12200

Roberts, R. E., Phinney, J. S., Masse, L. C., Chen, Y. R., Roberts, C. R., & Romero, A. (1999). The structure of ethnic identity of young adolescents from diverse ethnocultural groups. *Journal of Early Adolescence*, *19*, 301–322. doi:10.1177/0272431699019003001

Rowley, S., Kurtz-Costes, B., Mistry, R., & Faegans, L. (2007). Social status as a predictor of race and gender stereotypes in late childhood and early adolescence. *Social Development*, *16*, 150–168. doi:10.1111/j.1467-9507.2007.00376.x

Scroggins, W. A., Mackie, D. M., Allen, T. J., & Sherman, J. W. (2016). Reducing prejudice with labels: Shared group memberships attenuate implicit bias and expand implicit group boundaries. *Personality and Social Psychology Bulletin*, *42*, 219–229. doi:10.1177/0146167215621048

Telzer, E. H., & Fuligni, A. J. (2009). A longitudinal daily diary study of family assistance and academic achievement among adolescents from Mexican, Chinese, and European backgrounds. *Journal of Youth and Adolescence*, *38*, 560–571. doi:10.1007/s10964-008-9391-7

Telzer, E. H., & Garcia, H. A. V. (2009). Skin color and self-perceptions of immigrant and U.S.-born Latinas: The moderating role of racial socialization and ethnic identity. *Hispanic Journal of Behavioral Sciences*, *31*, 357–374. doi:10.1177/0739986309336913

Telzer, E. H., Humphreys, K. L., Shapiro, M., & Tottenham, N. (2013). Amygdala sensitivity to race is not present in childhood but emerges over adolescence. *Journal of Cognitive Neuroscience*, *25*, 234–244. doi:10.1162/jocn_a_00311

Tottenham, N., Tanaka, J. W., Leon, A. C., McCarry, T., Nurse, M., Hare, T. A., . . . Nelson, C. (2009). The NimStim set of facial expressions: Judgments from untrained research participants. *Psychiatry Research*, *168*, 242–249. doi:10.1016/j.psychres.2008.05.006

Uhlmann, E., Dasgupta, N., Elgueta, A., Greenwald, A. G., & Swanson, J. (2002). Subgroup prejudice based on skin color among Hispanics in the United States and Latin America. *Social Cognition*, *20*, 198–226. doi:10.1521/soco.20.3.198.21104

Umaña-Taylor, A. J., Quintana, S. M., Lee, R. M., Cross, W. E., Rivas-Drake, D., Schwartz, S. J., . . . Sellers, R. M. (2014). Ethnic and racial identity during adolescence and into young adulthood: An integrated conceptualization. *Child Development*, *85*, 21–39. doi:10.1111/cdev.12196

Van Bavel, J. J., Packer, D. J., & Cunningham, W. A. (2008). The neural substrates of in-group bias: A functional magnetic resonance imaging investigation. *Psychological Science*, *19*, 1131–1139. doi:10.1111/j.1467-9280.2008.02214.x

Van Bavel, J. J., Packer, D. J., & Cunningham, W. A. (2011). Modulation of the fusiform face area following minimal exposure to motivationally relevant faces: Evidence of in-group enhancement (not out-group disregard). *Journal of Cognitive Neuroscience*, *23*, 3343–3354. doi:10.1162/jocn_a_00016

Zerubavel, N., Bearman, P. S., Weber, J., & Ochsner, K. N. (2015). Neural mechanisms tracking popularity in real-world social networks. *Proceedings of the National Academy of Sciences*, *112*, 15072–15077. doi:10.1073/pnas.1511477112