# Cultural influences on positive affect and reward processing in depressed youth

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## Abstract

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Adolescent onset of depression is a public health concern because it is common and has been linked with subsequent episodes of depression, substance abuse, impaired social and academic functioning, and suicidal tendencies (Emslie et al, 2008; Kovacs, 1996; Kovacs et al.,1984; Weissman et al., 1999). Diminished positive affect and disrupted reward function, seen as the neural characteristic of positive affect, are implicated in early episodes of depression and also predict recurrent episodes of depression (Forbes, 2011; Joiner, Lewinsohn, & Seeley, 2002; Nandrino et al., 2004). Thus, studying positive affect and reward during the developmental period of adolescence may help us better understand the emergence of depression.

An increasing number of studies acknowledge the importance of examining the role of culture in the expression of depression. However, few studies have looked specifically at culture and reward dysfunction, and even fewer have looked at these constructs during a developmental period when depression is emerging. The expression of positive affect is shown to be shaped by cultural norms, with Asian Americans in general reporting less intense positive emotions than

European Americans due to the cultural emphasis to control and moderate emotion (Eid & Diener, 2001; Russell & Yik, 1996). In order to better understand the emergence of depression within this population, it may be useful to assess positive affect with measures that are less influenced by subjective experience. Prior research suggests that while culture may alter the subjective experience of emotion, there may be less contribution of culture with regards to physiological response (Levenson, 1999). Disrupted reward anticipation has been examined using electroencephalographic (EEG) measurements and several studies have found abnormal reward circuitry when comparing depressed to nondepressed samples (Davidson, 1998; Debener et al., 2000; Foti et al., 2011).

The overarching goal of this study is to explore how culture affects the expression of positive affect and reward among depressed Asian American and European American adolescents using multiple methods of data collection. The following hypotheses were examined: (1) whether race/ethnicity affects the relation between self-reported positive affect and depressive symptoms; (2) whether neural reactivity, measured using ERP P3 amplitude, towards both monetary and social reward predicts depressive symptoms and if this association is affected by race/ethnicity; and (3) if acculturation moderates the expression of positive affect and reward for Asian American adolescents.

Data was gathered in two phases in order to evaluate study hypotheses. In Phase One, 825 participants ages 18-19 were asked to fill out self-report measures online that assess for depression, positive affect, and acculturation. In Phase Two, 68 females were selected from Phase One based on race/ethnicity. Asian American participants were matched with European American counterparts based on depression severity on the PHQ-9 depression measure (Spitzer, Kroenke, & Williams, 1999). During the Phase Two lab visit, ERP data were collected during a

cued go/no-go task. Participants also completed a structured depression interview on the YA-DISC-IV (Shaffer, 2000).

Results suggest the negative association between positive affect and depression was significantly stronger for European American participants compared to Asian Americans. In addition, a trend towards significance was found with European American participants exhibiting increased P3 reactivity towards smiling European American faces as level of depression increased. Results from the proposed study can be used to guide the development of culturally sensitive ways to detect, prevent, and intervene with depression in Asian American youth.

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## Background

The onset of major depressive disorder is common in adolescence with prevalence estimated at 6% among adolescents in the United States and 1 in 5 adolescents having experienced at least one major depressive episode by age 18 (Costello, Erkanli, & Angold, 2006; Curry et al., 2011). Up to 70% of individuals with adolescent depression experience a recurrent episode within 2 years, and adolescent depression is associated with increased risk of persistent academic and social impairment, and increased rates of suicide attempts and completions (Emslie et al., 2008; Kovacs, 1996; Kovacs, Feinberg, Crouse-Novak, Paulauskas, & Finkelstein, 1984; Weissman et al., 1999). Subthreshold depression in adolescence has been linked to the subsequent development of major depression, substance use disorder, and suicidal tendencies (Fergusson, Horwood, Ridder, & Beautrais, 2005; Lewinsohn, Solomon, Seeley, & Zeiss, 2000). Given the potential for dire consequences, adolescent depression is a major public health concern and it is important to examine traits that may help with the identification of the disorder.

## Positive Affect

Depression is a disorder of emotion regulation that is associated with sustained negative affect and reduced positive affect (PA)(Joiner et al., 1996). While the research on how affect contributes to the emergence and maintenance of depression is still largely directed at negative emotions (e.g., sadness, fear, and guilt), more researchers are recognizing the value of studying positive affect to better understand emotion dysregulation and psychopathology (Feldman, Joormann, & Johnson, 2008). PA is described as/defined as pleasurable engagement with the environment and the extent an individual feels enthusiastic, active, and alert (Clark & Watson, 1991; Forbes et al., 2009). PA goes beyond the subjective experience of pleasant emotions and

involves behavioral, motivational, and physiologic features that are organized to obtain goals related to the pursuit and enjoyment of rewards.

In addition, PA can be viewed as a higher order dimension composed of several correlated, yet distinguishable, lower level affective states. These lower level affective states reflect the content of mood (e.g., happy, confident, calm, etc.) and are referred to as positive emotions. Furthermore, literature on PA often overlaps with research on subjective well-bring (SWB). SWB is defined as how and why people experience their lives in positive ways, including both emotional reactions and cognitive judgments (Diener, 1984). Concepts covered by SWB include happiness, life satisfaction, morale, and positive affect. Research on SWB indicates that it tends to be stable over time (Diener et al., 1999), is related to personality traits (Steel, Schmidt, & Shultz, 2008), and can have a beneficial influence on health (Diener & Chan, 1984). Positive emotion and SWB are two constructs that often overlap with PA and are sometimes used interchangeably with PA in the literature.

It is important to note that PA is not defined as the opposite of negative affect. Clark and Watson (1988) have found PA and negative affect to be separate constructs that are largely independent of one another and have distinctive correlational patterns with other variables. For example, PA -but not negative affect- is related to measures of social activity, exercise, the circadian rhythm, and reports of pleasant events (Clark & Watson, 1991). Similarly, PA is related to better self-regulation under stress, independent of the effects of negative affect (Moskowitz, Shmueli-Blumberg, Acree, & Folkman, 2012). The dimension of PA is better understood on a continuum ranging from positive mood and extraversion to lack of pleasurable engagement with the environment.

Research indicates that those who have frequent experiences of PA are better able to cope with stressful life events (Ong, Bergeman, Bisconti, & Wallace, 2006), enjoy better health (Cohen & Pressman, 2006), are more successful in their careers (Boehm & Lyubomirsky, 2008), and have longer lifespans (Carstensen et al., 2011). ). Overall, the experience of PA is considered a hallmark of resilience and positive quality of life endorsement (Fredrickson & Kurtz, 2011). In contrast, having a low level of PA has been examined as an early vulnerability factor for depression (Olino et al., 2011), has been shown to predict recurrent episodes of depression (Joiner, Lewinsohn, & Seeley, 2002).

Diminished PA is linked to anhedonia, a core feature of depression. Anhedonia is defined as loss of pleasure in all or most activities and/or lack of reactivity to usually pleasurable stimuli. Anhedonia is reflected in decreased engagement with the environment, deactivation in reward processing, and diminished positive affect, defined by the extent to which an individual feels enthusiastic, active, and alert (Clark & Watson, 1991; Forbes et al., 2009). Low positive affect/decreased engagement while depressed has been shown to predict recurrence of depression (Joiner, Lewinsohn, & Seeley, 2002) and adolescent anhedonia predicts later major depressive disorder during adulthood (Pine, Cohen, Cohen, & Brook, 1999). Conceptual models of depression indicate disrupted reward function as a neural characteristic of low positive affect (Forbes, 2011). Similar to low positive affect, altered reward function is characteristic of early episodes of depression (Nandrino, Dodin, Martin, & Henniaux, 2004).

**PA and adolescence**

Adolescence, the transitional stage of physical, psychological, and social development from childhood to adulthood, is a sensitive period for reward function and the development of depression. In terms of chronological age, there is no standard age range to define adolescence,

although the American Psychological Association uses the age range 10 to 18 (American Psychological Association, 2002), while the World Health Organization uses the age range 10 to 19 (World Health Organization, 2013). Adolescents in general tend to engage in more risky reward-seeking behaviors (e.g., reckless driving, substance abuse, unprotected sex) than children and adults (Somerville, Jones, & Casey, 2010), have increased reward sensitivity, and experience rewards more intensely (Steinberg, 2008). Conversely, adolescents also have low levels of momentary positive affect, with average emotional state becoming less positive across early adolescence (Larson, Moneta, Richards, & Wilson, 2002) as well as having increasing levels of depressive symptoms (Sawyer, Pfeiffer, & Spence, 2009). Furthermore, emerging adulthood, which begins around age 18 and overlaps with late adolescence, is characterized by increases in stress with individuals struggling to establish their autonomy, facing instability in their social identities, and many undergo a transition to college where they have increased demands and responsibilities (Arnett, 2000). Taken together, it may be of importance to study positive affect and reward processing in adolescents to better understand the emergence of depression.

**Cultural differences of PA**

It is important to note that the research on low positive affect and reward function in depression was conducted largely using European American samples; however culture may shape the expression of positive affect and reward. Studies have found that Asian Americans self-report and behaviorally display less intense positive emotions than European Americans (Diener, Diener & Diener, 1995; Kitayama, Markus, & Kurokawa, 2000). Because low levels of positive affect are associated with depression, it is important to understand whether Asian Americans are having less positive experiences or if cultural factors may be influencing the

report of positive affect in order to better understand the emergence of depression within this population.

Decreased report of positive affect may be partially explained by dialectic values, which stem from Buddhist beliefs and are more common in East Asian cultures (Bagozzi et al., 1999). Within a dialectic approach, traditionally opposing emotions such as happy and sad are viewed as mutually independent and can coexist in a state of balance. Because of this way of thinking, it has been hypothesized that Asian individuals report mixed feelings in response to a positive event. Individuals with dialectic beliefs may perceive positive events as negative because the events may result in negative social consequences, such as envy by others. Similarly, negative events may be viewed as positive because it may elicit positive experiences, such as sympathy from others. Furthermore, in contrast to European American culture, East Asian cultures emphasize the importance of emotional control and moderation, which are reflected in reports of less intense positive and negative emotional experiences (Eid & Diener, 2001; Russell & Yik, 1996). When receiving a good grade in class, Japanese students tend to dampen, as opposed to savor, their positive emotions and reported a more moderate experience of positive events because they were concerned about disrupting group harmony (Miyamoto & Ma, 2011).

With regard to depression, among European American, Asian American, and immigrant Asian adults, self-reported positive affect is negatively associated with depressive symptoms among European Americans but not immigrant Asians (Leu, Wang, & Koo, 2011). In this study, acculturation, the process of adaptation to a host culture by individuals, mediated the relation between self-reported positive affect and depressive symptoms for Asian Americans. Acculturation is helpful in understanding within-group variability and is associated with multiple psychological, behavioral, and health outcomes such as stress, depression, and drug use (Leu,

Walton, & Takeuchi, 2011; Lorenzo-Blanco et al., 2011; Sirin et al., 2013). Other studies have also emphasized the impact of acculturation in the expression of positive affect, with greater levels of acculturation leading to greater reports of positive affect (Jang, Kim, & Chiriboga, 2005; Kim, Seo, & Cain, 2010).

Chentsova-Dutton and colleagues (2007) introduced the cultural norm hypothesis and predicted symptoms of depression may impair an individual's ability to enact cultural norms regarding emotion expression. For example, in cultures that value open expression of emotion, depression should be related to failure to express emotions, particularly positive emotional responses. In cultures that emphasize moderation of emotions, such as in Asian cultures, depression may be associated with a failure to moderate emotions and may even result in enhanced positive reactivity. In response to an amusing film clip, Chentsova-Dutton and colleagues (2010) found that while depressed European Americans reported decreased positive emotion compared to control European Americans, depressed Asian Americans expressed similar and even greater positive emotion compared to control Asian Americans. In their 2007 study, they found no cardiac, vascular, electrodermal, or respiratory differences between depressed European American and Asian Americans when shown a sad and an amusing film clip. In sum, while depression and report of positive affect are negatively correlated for European Americans, this association may not be as strong for Asian Americans. However this cultural discrepancy does not appear when using physiological measures.

Proponents of the "core emotion system" suggest a biologically innate processing system for emotional states that is hard-wired and relatively impermeable to modification by experience (Levenson, 1999). They expect that when examining physiological reactivity of an emotional experience, there is less contribution of culture and greater contribution of biology, which leads

to universality in physiological response. When asked to recall previous emotional episodes, Tsai and colleagues (Tsai, Chentsova-Dutton, Freire-Bebeau, & Przymus, 2002) found no differences in physiological response among Hmong Americans and European Americans. While these results are consistent with the core emotion system, both this study and the 2007 Chentsova-Dutton study (Chentsova-Dutton et al., 2007) mentioned the task they used may not have elicited enough of a response to detect group differences. Furthermore, the Chentsova-Dutton study was not able to measure exposure to and endorsement of cultural norms within their sample. Methodological issues make it challenging to interpret results and speak to the importance of considering the influence of culture and using multiple methods of assessment to establish a more complete picture of the experience of depression. Using a multimodal assessment approach which includes behavioral expression, self-report of psychological experience, and physiological responses will allow for a more comprehensive understanding of reward processing and how culture may impact the expression of positive affect.

**Biological measures of PA**

There is mounting evidence to support the use of biological measures to assess positive affect and reward functioning. Research using electroencephalographic (EEG) measurements has revealed disrupted reward processing in those who are depressed. Depressed individuals exhibit reduced resting activity in left relative to right frontal cortical regions, which reflects activity in the dorsolateral prefrontal cortex and indicates a deficit in approach motivation (Davidson, 1998; Debener et al., 2000). Anhedonia has been related to increased resting delta current density (i.e., decreased resting activity) in the ventromedial prefrontal cortex (vmPFC) and rostral anterior cingulate cortex (rACC) regions (Wacker, Dillon, & Pizzagalli, 2009). The delta rhythm is associated with stimulus elicited activity in the brain's reward circuit and there is a positive

correlation between anhedonia and delta current density in the subgenual anterior cingulate cortex. These cortical areas have been implicated in reward-guided decision making (Rushworth, Behrens, Rudebeck, & Walton, 2007). In experimental studies, while non-depressed individuals exhibit an increase in left frontal brain activity when anticipating a monetary reward, depressed individuals do not (Shankman, Klein, Tenke, & Bruder, 2007). Blunted neural response to monetary gains and losses was also seen in adolescents at risk for depression (Foti, Kotov, Klein, & Hajcak, 2011). Taken together, these results suggest that developmental abnormalities in reward circuitry, including frontal striatal and limbic areas, may form the neurobiological basis of abnormal reward functioning in depression. However this method has not been employed in cross-cultural studies of positive affect.

**The role of social reward**

Furthermore, research examining reward function in depression has focused on monetary reward while few studies have looked at social reward. Depression is strongly linked with social function. Social stressors have been shown to influence the development and course of depression in adolescents (Sheeber, Hops, & Davis, 2001) and may play a particularly important role during this developmental stage given the importance of peer relationships. Research with adolescents has found that social rewards elicit positive affect as well as reactivity in reward related neural regions (Davey, Allen, Harrison, Dwyer, & Yucel, 2010). Moreover, collectivistic values commonly held in Asian cultures have been linked to greater sensitivity to social events (Way & Lieberman, 2010), thereby underscoring the importance of investigating responses in the context of social rewards. Therefore, it is important to consider social as well as monetary reward to better understand cultural variations in reward processing and positive affect.

**Go/no-go task**

The cued incentive go/no-go task has been frequently used to assess reward anticipation, goal directed behavior, and a potential rewarding outcome. Using a cued incentive go/no-go task and measuring event-related brain potentials (ERPs) in healthy adults, the amplitude of the P3 ERP component was elicited by cues that triggered reward anticipation and modulated by monetary magnitude, with the highest P3 amplitudes seen for the largest potential rewards (Goldstein et al., 2006). The P3 response usually peaks between 300 and 600 ms after stimulus onset, with the largest amplitudes seen at centro-parietal scalp sites. More motivating, salient stimuli elicit larger P3 amplitudes in children and adults (Nieuwenhuis, Aston-Jones, & Cohen, 2005). Previous studies have used the go/no-go task with both monetary and social reward (positive facial expressions) contingencies in typically developing children and children diagnosed with autism spectrum disorders (Kohls, Peltzer, Herpertz-Dahlmann, & Konrad, 2009). Children with autism who show reduced social motivation, display attenuated P3 activity in response to both monetary and social incentives (Kohls et al., 2011). To our knowledge, reward anticipation has not been assessed in depressed adolescent and young adult samples using this approach. By employing a go/no-go task with both monetary and social reward contingencies to elicit ERPs, we are better equipped to assess how culture may influence reward function, the expression of positive affect, and the emergence of depression among Asian American adolescents.

**Study Aims**

This study examines whether race/ethnicity and level of acculturation influence the expression of positive affect and reward processing among depressed Asian American and European American adolescents using a two-step approach, first involving administration of a set of screening questionnaires (Phase One), followed by an in-depth exploration using self-report

and physiological measures with a subset of the original sample (Phase Two). Specific aims and hypotheses are as follows (see Figure 1):

***Phase One***

*Aim 1*: To explore whether race/ethnicity influences the relation between self-reported positive affect and depressive symptoms.

H1. There will be a negative relation between positive affect and depressive symptoms for both European American and Asian American adolescents, with a stronger correlation for European American youth.

*Aim 2*: To explore whether acculturation moderates the expression of positive affect for Asian American adolescents.

H2. Greater acculturation will be associated with a stronger negative association between self-reported positive affect and depression.

***Phase Two***

*Aim 1*: To examine whether neural reactivity to reward predicts depressive symptoms and test whether this association is moderated by race/ethnicity.

H1a. In European American adolescents, blunted reactivity to monetary and social reward incentives as indicated by an abnormal P3 component in a cued go/no-go task will be associated with higher levels of depressive symptoms.

H1b. Similar to European American adolescents, in Asian American adolescents, blunted reactivity to monetary reward will be associated with higher levels of depressive symptoms.

H1c. Because of the importance placed on social interaction in collectivistic culture, the relation between blunted response to social reward and depressive symptoms will be stronger

(i.e., more blunted response for those with greater depressive symptoms; stronger negative correlation) for Asian American adolescents than European American.

*Aim 2*: To explore whether acculturation moderates the expression of reward for Asian American adolescents.

H2. Greater acculturation will be associated with a weaker negative correlation between blunted response to social reward and depressive symptoms.

**Methods**

In Phase One, participants were 437 European Americans and 388 Asian American college students, recruited from a public university in the US. Participants earned extra course credit. General eligibility criteria for participating in the study were: (1) 18 to 19 years of age, (2) self-identify as either Asian or European American, and (3) able to read and write in English. Of the participants, 34.7% identified as male, 64.7% as female, and 0.6% chose not to identify their biological sex. All participants completed an hour-long online survey on measures of demographics, positive affect, culture, depression, and other psychopathology (see Measures section).

In Phase Two, 68 females were selected from Phase One based on race/ethnicity. Asian American participants were matched with European American counterparts based on depression severity on the PHQ-9 depression measure (Spitzer, Kroenke, & Williams, 1999). Participant scores on the PHQ-9 ranged in severity from "none" to "severe." Approximately one third of participants fell within the "none" depression severity range, one third within the "mild" range, and one third within the "moderate" to "severe" range. Only females were recruited for the second phase due to the lower prevalence of depression in males, and the exploratory nature of the research. Additional exclusion criteria for Phase Two included: (1) presence of psychotic

and/or manic symptoms as indicated on the MDQ; and (2) a ASR score greater than the clinical cut-off (T-score 65). Participants were asked to complete a series of tasks in in a one-time laboratory visit and were given a $35 monetary incentive. The final sample for Phase Two was 33 European American and 35 Asian American participants

**Measures**

Study measures are described below.

*Phase One Computerized Interview:*

A demographics questionnaire was used to collect information on the participant's age, sex, racial/ethnic background, SES bracket, years of education, etc.

The Patient Health Questionnaire (PHQ-9; (Spitzer, Kroenke, & Williams, 1999)) is a 9-item depression tool used for diagnosing depression and is based on the Diagnostic and Statistical Manual Fourth Edition (DSM-IV) criteria for major depressive disorder. The diagnostic validity of the PHQ-9 has been established in several studies and it is a sensitive measure of depression.

The Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977) is comprised of 20 items that represent major components of clinical depression. The items on the scale assess for positive affect, negative affect, somatic symptoms, and interpersonal difficulties. Individuals are asked to rate each item on a scale from 0 to 3 to indicate how often they felt that way over the previous week. Researchers have investigated the reliability and validity of the CES-D with African American, Asian American, French, Greek, Hispanic, Japanese, and Yugoslavian populations (Naughton & Wiklund, 1993).

The Positive and Negative Affect Scale (PANAS; Clark & Watson, 1991) is a 20-item, self-report measure that consists of two 10-item mood scales that assess the separate dimensions

of positive and negative affect (Watson & Clark, 1994). Items (e.g., alert, determined, enthusiastic) are rated on a 5-point Likert scale. Its psychometric properties are strong, including internal validity as well as constrict, convergent, and discriminant validity. The total score of the 10-item positive affect subscale was used in correlations and regression models described below.

The Asian American Multidimensional Acculturation Scale (AAMAS; Chung, Kim, & Abreu, 2004) is a 45-item bidimensional measure of acculturation that takes into account both orientation to European American culture (i.e., acculturation), as well as retention of one's culture of origin (i.e., enculturation). This bidimensional approach acknowledges the complexity of acculturation and posits that individuals can be acculturated to one culture, two cultures, or neither culture. Exploratory and confirmatory factor analyses have found support for four specific acculturation domains within the scale: language, food consumption, cultural knowledge, and cultural identity. Internal consistency for the subscales range from .76 to .91 and reliability estimates range from .75 to .89. Items assessing orientation to European American culture were totaled to measure acculturation and items assessing orientation to pan-ethnic Asian American culture were used to measure enculturation. The dimensional totals from this measure were included as moderators in regression models outlined below.

The Mood Disorder Questionnaire (MDQ; Hirschfeld et al., 2000) is a brief 17-item screening instrument for bipolar disorders. Within the general population, the tool yields a sensitivity of .28 and specificity of 0.97. For primary care patients receiving treatment for depression, the tool yields a sensitivity of .58 and specificity of .93. This measure was used to screen out the presence of psychotic and manic symptoms.

The Adult Self Report (ASR; Achenbach, 2003) is a 126-item measure covering physical problems, concerns, and strengths. The 35-item externalizing subscale will be used for this

project. Participants rate themselves for how true each item is for them on a 3-point Likert scale of often true, sometimes true, not true. This measure was used to screen out clinical levels of externalizing symptoms.

*Phase Two Lab Visit:*

The Young Adult Diagnostic Interview Schedule for Children (YA-DISC-IV; Shaffer, 2000) was used to confirm depression group status and as the main outcome in the Phase Two statistical analyses outlined below. It assesses DSM-IV psychiatric symptoms and diagnoses in older adolescents and young adults up to age 24. The YA-DISC-IV items are organized by diagnosis so I will be using the major depressive disorder module. With the YA-DISC-IV, I can obtain information on whether the participant met diagnostic criteria for depression and also get a continuous symptom count. The measure will be administered by a trained member of the research team. Items include questions such as "In the last year…was there a time when you often felt sad or depressed for a long time each day?" and "In the last year…was there a time when nothing was fun for you and you just weren't interested in anything?"

The PANAS (Clark & Watson, 1991) will be given during the Phase Two lab visit, before and after the experimental procedure.

**Phase Two Experimental Procedure**

Adolescents completed interviews and questionnaires (see above), followed by a go/no-go reward task during which event-related potentials (ERP) were assessed. Participants were seated in a comfortable chair in front of a desktop computer in a small, sound-attenuated room that was monitored via video equipment. EEG was collected using BioSemi ActiveTwo recording system (CorTech Solutions, Wilmington, NC). Scalp potential sequences were sampled at 256 Hz from 64 active electrode sensors and digitally low-pass filtered below 50Hz.

Independent component analysis was used to identify weighted combinations of sensor locations that best matched the timing and topography of eye blinks. These blink components were subtracted, and the resulting scalp potential sequences were referenced to the sensor positioned below the left eye, the closest location in our montage to the nose-tip reference used by (Kohls et al., 2011).

Digital codes embedded in the recording files marked the onset of each stimulus sequence and identified its category. These digital markers were used to extract 800 millisecond segments of evoked response data, plus a 100 millisecond prestimulus baseline period. For each sensor and segment, the average potential during the baseline period was subtracted from the entire segment's data sequence. Trial segments containing mechanical or other large electrical artifact were discarded before computing mean evoked response sequences for each sensor and stimulus category.

*Cued Incentive Go/no-go Task (see Figure 2)*

A modified version of the emotional go/no-go paradigm (Hare et al., 2005) was used. Three different reward conditions (non-reward (NR), monetary reward (MR) and social reward (SR) were presented across 6 experimental blocks of 60 trials each consisting of either go or no-go trials. The order of the 6 blocks were randomized across participants and the order of the trials randomized within each block. Each reward condition was comprised of the same ratio of go to no-go trials (60 trials per condition; 65% go trials = 39, and 35% no-go trials = 21). At the onset of each trial, an instruction cue was presented for 250 ms, indicating either a go trial (downward arrow) or a no-go trial (upward arrow). One second after the cue, the target stimulus/response time window (black square) was presented for 500 ms. The pre-target period will be examined as the anticipation phase. During the anticipation phase, a fixation cross was shown in the center of

the screen. Participants were instructed to respond with their finger on a response console as quickly and accurately as possible upon seeing the target after the go cue and to refrain from responding upon seeing the target after the no-go cue.

Depending on the reward condition, subjects were rewarded for successful task performance (i.e., a fast and accurate button press in go trials and an inhibitory response in no-go trials) for 1,500 ms immediately after target disappearance. In the MR condition, correct task performance was rewarded with money, symbolized by wallets filled with quarters. Empty wallets were shown following errors. All participants won an additional $5, irrespective of their performance, although they were told that better performance would result in a larger amount of money paid after the experimental session. In the SR condition, positive facial expressions served as rewards, and neutral faces were shown after errors. All facial stimuli came from the NimStim Face Stimulus Set (Tottenham et al., 2009) and were equal in size and luminance. In the NR condition, an image was given for both successful and failed task performance. Images were produced to resemble the social and monetary feedback pictures in size and complexity. Following this feedback, a fixed intertrial interval of 1,000 ms was shown (indicated by a fixation cross). In prior studies, the percentage of correct responses for typically developing children in go trials were 87.8% for the NR condition, 94.4% for the MR condition, and 92.7% for the SR condition (Kohls et al., 2011).

Response cost manipulations in the go/no-go task (e.g., losing money for false alarms in the monetary reward block) were not included given the study's focus on motivational effects of rewarding stimuli and not punishment or punishment avoidance. To ensure all participants understood the task instructions, all blocks were preceded by 30 practice trials (10 trials in each

reward condition), with the opportunity to repeat the practice trials if needed. In total, the lab visit lasted approximately 60-80 minutes.

**Statistical Analyses**

**Phase One**

*Aim 1: To explore whether race/ethnicity influences the relation between self-reported positive affect and depressive symptoms.* Descriptive statistics for race/ethnicity, sex, PHQ-9 depression, PANAS positive affect, AAMAS acculturation, and AAMAS enculturation were examined. Correlations were run between the PANAS positive affect subscale score and PHQ-9 depression score. An independent samples t-test was run to detect statistically significant group differences between European American and Asian American adolescents for depression and positive affect. A regression model was computed with positive affect predicting PHQ-9 depression score using race/ethnicity (European American, Asian American) as a moderator. Sex was factored in as a covariate.

*Aim 2: To explore whether acculturation moderates the expression of positive affect and reward for Asian American adolescents.* Focusing on Asian American participants only, a regression model was computed in which the significance of acculturation, as measured by the AAMAS, was tested as a moderator of the relation between PANAS positive affect and PHQ-9 depression score. The dimensions of acculturation (acculturation and enculturation) were run in separate regression models.

**Phase Two**

*Aim 1: To examine whether neural reactivity to reward predicts depressive symptoms and test whether this association is moderated by race/ethnicity.* Analysis focused on the P3 response as the ERP component of interest that has been linked to anticipation of reward. P3 was

measured from both the Cz and Pz electrode sites separately. Single subject averages were calculated for the three reward conditions. The data was segmented into epochs from 200 ms before to 500 ms after the reward cue and after target onset and baseline corrected to -200 ms. Algorithms were applied post data collection to remove eye movements. The P3 amplitude of single subject averages for go and no-go trials was measured as the mean waveform peak in the period 250-450 ms after event onset using an automatic peak detection function.

Descriptive statistics for race/ethnicity, YA-DISC-IV depression symptom count, pre- and post-EEG task PANAS positive affect, and P3 averages were examined. Using repeated-measures ANOVA,within-subject differences were also examined to examine whether there were P3 response differences based on reward type, as well as go versus no-go trial.

The ERP data were analyzed within a regression model with average P3 amplitude predicting YA-DISC-IV depression score using race/ethnicity (European American, Asian American) as a moderator. These analyses were run separately for monetary reward and social reward type. Analyses were also run separately for go trials and no-go trials.

*Aim 2: To explore whether acculturation moderates the expression of positive affect and reward for Asian American adolescents.* Focusing on Asian American participants only, a regression model was computed in which the significance of acculturation, as measured by the AAMAS, was tested as a moderator of the relation between neural response to reward and YA-DISC-IV depression symptom count. The dimensions of acculturation (acculturation and enculturation) were run in separate regression models.

**Results**

*Phase One Descriptive Statistics, Correlations, and T-Tests*

Descriptive statistics for race/ethnicity, sex, PHQ-9 depression, PANAS positive affect, AAMAS acculturation, and AAMAS enculturation were examined (see Tables 1, 2, and 3). Depression on the PHQ-9 and PANAS positive affect were significantly correlated for both Asian American ($r = -0.31$, $p < .01$) and European American participants ($r = -0.48$, $p < .01$), with a more negative association found for European Americans. Significant mean differences were found between European and Asian American participants for depression and positive affect (see Table 4). For Asian Americans, mean positive affect scores were significantly lower ($t = 8.48$, $p < .001$) and mean depression scores were higher ($t = -2.98$, $p < .01$) when compared to European American counterparts. Interestingly, when looking at male and female mean scores separately, racial/ethnic differences for depression disappear for females. Racial/ethnic differences are significant for males with higher mean depression scores for Asian Americans ($t = -4.03$, $p < .001$), but there were no racial/ethnic differences in depression for females ($t = -0.83$, $p = .41$).

*Aim 1: To explore whether race/ethnicity influences the relation between self-reported positive affect and depressive symptoms.*

A regression model was computed with PANAS positive affect predicting PHQ-9 depression score using race/ethnicity as a moderator and sex as a covariate (see Table 5). The interaction of positive affect × race significantly predicted depression ($t = 2.57$, $p = .01$) (see Figure 3). This effect was over and above the significant main effect of positive affect ($t = -12.49$, $p < .001$) and the non-significant main effect of race ($t = -.50$, $p = .62$). Congruent with the correlations mentioned above, the association between positive affect and depression is stronger for European American participants to Asian Americans. Sex also significantly predicted depression ($t = 2.30$, $p = .02$).

*Aim 2: To explore whether acculturation moderates the expression of positive affect and reward for Asian American adolescents.*

Focusing on Asian American participants only, a regression model was computed in which the significance of acculturation, as measured by the AAMAS, was tested as a moderator of the relation between PANAS positive affect and PHQ-9 depression score. The positive affect × acculturation interaction did not significantly predict depression ($t = -1.12$, $p = .26$), nor did the main effect of acculturation ($t = -.69$, $p = .49$). Similarly, a regression model was computed to test the significance of enculturation as a moderator between positive affect and depression. Neither the interaction ($t = .29$, $p = .77$) nor the main effect ($t = .86$, $p = .39$) were significant.

*Phase Two Descriptive Statistics, Correlations, and T-Tests*

Descriptive statistics for race/ethnicity, YA-DISC-IV depression symptom count, pre- and post-EEG task PANAS positive affect, and P3 averages were examined (see Table 6). YA-DISC-IV depression symptom count was not significantly correlated to any of the positive affect or P3 measures for either Asian or European American participants (see Tables 7, 8, 9, 10, 11, and 12). Comparing group means, a trend towards significance was found for post-EEG task positive affect ($t = 1.85$, $p = .07$) and P3 average on monetary reward go trials ($t = 1.68$, $p = .10$), with Asian Americans having lower means on both (see Table 13). No significant mean differences were found for YA-DISC-IV depression, pre-EEG task positive affect, P3 average on social reward trials with Asian or European American faces, or P3 average on neutral reward trials when comparing Asian and European American participants.

Using repeated-measures ANOVA,within-subject differences were also examined to examine whether there were P3 response differences based on reward type, as well as go versus no-go trial (see Table 14). While responses were not significantly different for go versus no-go

trials (F = 2.06, p = .16), participants responded differently to the three reward types (F = 18.83, p < .001). Overall, participants exhibited greater P3 response to monetary reward, compared to neutral and social rewards (see Figure 4).

*Aim 1: To examine whether neural reactivity to reward predicts depressive symptoms and test whether this association is moderated by race/ethnicity.*

A regression model was computed with average P3 amplitude predicting YA-DISC-IV depression symptom count using race/ethnicity as a moderator. P3 amplitudes from go trials and from no-go trials were examined separately. P3 amplitudes for Cz and Pz electrode sites were examined separately. Starting with go trials and using the Cz electrode site, the P3 × race/ethnicity interaction did not significantly predict depression for social reward trials with Asian faces (t = -.85, p = .40), social reward trials with European American faces (t = .30, p = .77), monetary reward trials (t = -.28, p = .78), or neutral reward trials (t = -.90, p = .37). No main effects were found for race/ethnicity or P3 amplitude on any of the go trials. Similarly, using the Pz electrode site, the P3 × race/ethnicity interaction did not significantly predict depression for social reward trials with Asian faces (t = -.22, p = .83), social reward trials with European American faces (t = .61, p = .54), monetary reward trials (t = -.29, p = .77), or neutral reward trials (t = -.90, p = .37). No main effects were found for race/ethnicity or P3 amplitude on any of the go trials.

For no-go trials using the Cz electrode, there was a trend towards significance for the P3 × race/ethnicity interaction during social reward trials with European American faces (t = -1.70, p = .09) (see Table 15 and Figure 5). European Americans showed a more steep positive relation between P3 amplitude and depression during social reward trials with European American faces, when compared with Asian Americans. As depression increased, European American

participants exhibited increased P3 reactivity towards smiling European American faces on trials when they were asked to inhibit their response. The P3 × race/ethnicity interaction did not significantly predict depression for social reward trials with Asian faces (t = -.1.28, p = .21), monetary reward trials (t = -.86, p = .40), or neutral reward trials (t = -1.16, p = .25). Similarly, using the Pz electrode site, the P3 × race/ethnicity interaction did not significantly predict depression for social reward trials with Asian faces (t = -.22, p = .83), social reward trials with European American faces (t = -.58, p = .56), monetary reward trials (t = -.26, p = .79), or neutral reward trials (t = -.30, p = .76). No main effects were found for race/ethnicity or P3 amplitude on any of the no-go trials.

*Aim 2: To explore whether acculturation moderates the expression of positive affect and reward for Asian American adolescents.*

Focusing on Asian American participants only, a regression model was computed in which the significance of acculturation, as measured by the AAMAS, was tested as a moderator of the relation between neural response to reward and YA-DISC-IV depression symptom count. P3 amplitudes from go trials and from no-go trials were examined separately. P3 amplitudes for Cz and Pz electrode sites were examined separately. Starting with go trials and using the Cz electrode site, the P3 × acculturation interaction did not significantly predict depression for social reward trials with Asian faces (t = 1.04, p = .31), social reward trials with European American faces (t = .18, p = .86), monetary reward trials (t = .17, p = .86), or neutral reward trials (t = .79, p = .44). Similarly, the P3 × enculturation interaction also did not significantly predict depression for social reward trials with Asian faces (t = .72, p = .48), social reward trials with European American faces (t = .19, p = .85), monetary reward trials (t = .89, p = .38), or neutral reward trials (t = .93, p = .36). No main effects were found for race/ethnicity or P3 amplitude on any of

the go trials. Consistent with the Cz electrode, there were also no significant findings using the Pz electrode site. The P3 × acculturation interaction did not significantly predict depression for social reward trials with Asian faces ($t = .27$, $p = .78$), social reward trials with European American faces ($t = .04$, $p = .97$), monetary reward trials ($t = .03$, $p = .97$), or neutral reward trials ($t = .62$, $p = .54$). Likewise, the P3 × enculturation interaction also did not significantly predict depression for social reward trials with Asian faces ($t = .29$, $p = .78$), social reward trials with European American faces ($t = .32$, $p = .75$), monetary reward trials ($t = .94$, $p = .36$), or neutral reward trials ($t = 1.51$, $p = .14$). No main effects were found for race/ethnicity or P3 amplitude on any of the go trials.

The same trends held true for the no-go trials. Using the Cz electrode site, the P3 × acculturation interaction did not significantly predict depression for social reward trials with Asian faces ($t = -.28$, $p = .78$), social reward trials with European American faces ($t = 1.03$, $p = .31$), monetary reward trials ($t = 1.14$, $p = .26$), or neutral reward trials ($t = .48$, $p = .64$). Similarly, the P3 × enculturation interaction also did not significantly predict depression for social reward trials with Asian faces ($t = 1.21$, $p = .24$), social reward trials with European American faces ($t = .46$, $p = .65$), monetary reward trials ($t = .26$, $p = .80$), or neutral reward trials ($t = 1.38$, $p = .18$). For the Pz electrode site, the P3 × acculturation interaction also did not significantly predict depression for social reward trials with Asian faces ($t = .32$, $p = .75$), social reward trials with European American faces ($t = 1.48$, $p = .15$), monetary reward trials ($t = .82$, $p = .42$), or neutral reward trials ($t = .48$, $p = .64$). In addition, the P3 × enculturation interaction did not significantly predict depression for social reward trials with Asian faces ($t = 1.25$, $p = .22$), social reward trials with European American faces ($t = .26$, $p = .79$), monetary reward trials

($t = .22$, $p = .83$), or neutral reward trials ($t = .95$, $p = .35$). No main effects were found for race/ethnicity or P3 amplitude on any of the no-go trials.

*Exploratory analyses*

Given the above null results, exploratory analyses were run in order to better understand the nuances of the Phase Two data. As mentioned in the Phase Two descriptive statistics section, within-subjects analyses indicated participants reacted differently to the three reward types, with overall higher average P3 amplitudes seen for monetary rewards compared to social and neutral reward. Post-hoc analyses focused on whether the differences in how a participant reacted to each reward type might better predict level of depression. Three difference score variables were created by subtracting social reward (European American faces) average from monetary reward average, social reward (Asian faces) average from monetary reward average, and neutral reward average from monetary reward average. These difference score variables were then plugged into regression models to see whether they would interact with race/ethnicity to predict depression. The interaction between the difference scores and race/ethnicity did not significantly predict depression on the YA-DISC-IV, nor were there any significant main effects.

A second set of exploratory analyses focused on using a different depression measure as an outcome variable. Although Phase Two participants were recruited to represent a full range of depression based on the PHQ-9, only 3 participants met criteria for a major depressive episode in the last year on the YA-DISC-IV. As so few of the participants met criteria for major depression on the diagnostic tool, for the purposes of this study, it seemed useful to utilize another depression measure with items that are more fitting with the study aims. The CES-D, collected during Phase One of the study, was next examined as an outcome measure in Phase Two analyses. The CES-D assesses for positive affect, negative affect, somatic symptoms, and

interpersonal difficulties, and has been validated with Asian and Asian American populations (Naughton & Wiklund, 1993).

Starting with Phase One analyses, descriptive statistics for race/ethnicity, sex, CES-D depression, PANAS positive affect, AAMAS acculturation, and AAMAS enculturation were examined (see Tables 1, 2, and 3). Depression on the CES-D and PANAS positive affect were significantly correlated for both Asian American ($r = -0.42$, $p < .01$) and European American participants ($r = -0.61$, $p < .01$), with a more negative association found for European Americans. Significant mean differences were found between European and Asian American participants for CES-D depression (see Table 4). For Asian Americans, mean depression scores were higher ($t = -3.97$, $p < .001$) when compared to European American counterparts. This was consistent with results found using the PHQ-9. When looking at male and female mean scores separately, there are still significant racial/ethnic differences for both males ($t = -4.04$, $p < .001$) and females ($-2.10$, $p = .04$). Asian Americans had higher mean depression scores, compared with European Americans, for both sexes.

A regression model was computed with PANAS positive affect predicting CES-D depression score using race/ethnicity as a moderator and sex as a covariate (see Table 16). The interaction of positive affect × race significantly predicted depression ($t = 3.59$, $p < .001$) (see Figure 6). This effect was over and above the significant main effect of positive affect ($t = -17.43$, $p < .001$) and the non-significant main effect of race ($t = -.56$, $p = .57$). Similar to results using the PHQ-9 as an outcome, the association between positive affect and depression is stronger for European American participants to Asian Americans. Sex also significantly predicted depression ($t = 2.08$, $p = .04$).

Focusing on Asian American participants only, a regression model was computed in which the significance of acculturation was tested as a moderator of the relation between PANAS positive affect and CES-D depression score. As with the PHQ-9 results, the positive affect × acculturation interaction did not significantly predict depression ($t = -.85$, $p = .40$), however there was a significant main effect of acculturation ($t = -2.00$, $p = .05$) and positive affect ($t = -7.96$, $p < .001$) (see Table 17). Also, in contrast to PHQ-9 results above, there was a trend towards significance for enculturation as a moderator between positive affect and depression ($t = 1.87$, $p = .06$) (see Figure 7), as well as main effects of both enculturation ($t = 1.97$, $p = .05$) and positive affect ($t = -9.00$, $p < .001$) (see Table 18).

Phase Two results using the CES-D as an outcome were similar to previous results utilizing the YA-DISC-IV. There were no significant interactions for both Cz and Pz electrode sites, however one main effect was found (see Table 19). For the Cz electrode site, social reward trials with European American faces significantly predicted CES-D, with greater P3 reactivity associated with lesser depression on the CES-D ($t = -2.17$, $p = .03$). Overall within this study, neural reactivity to reward did not predict depressive symptoms, nor was it moderated by race/ethnicity.

**Discussion**

This study examined whether race/ethnicity and level of acculturation influence the expression of positive affect and reward processing in relation to report of depressive symptoms among Asian American and European American adolescents. Phase One explored whether race/ethnicity influences the relation between self-reported positive affect and depressive symptoms. Phase Two examined whether race/ethnicity moderates the relation between neural reactivity to reward, measured using P3 amplitude, and depressive symptoms. Both phases

investigated whether acculturation moderated the association between reward and depression for Asian American participants.

Consistent with the hypothesis, race/ethnicity moderated the relation between self-reported positive affect and depressive symptoms. The interaction of positive affect × race significantly predicted depression, over and above the main effects of positive affect and race. Congruent with previous studies, as report of depression increases, positive affect decreases for both racial/ethnic groups. However, European American participants show a more negative relation between positive affect and depression when compared to Asian Americans. These racial/ethnic differences may be partially explained by greater dialectic values found more commonly in Asian cultures (Bagozzi et al., 1999). Within a dialectic approach, opposing emotions such as happy and sad are viewed as mutually independent and can coexist in a state of balance. Because of this, individuals with greater dialectic beliefs are less likely to report a stark contrast between positive and negative emotions. Furthermore, in contrast to European American culture, East Asian cultures emphasize the importance of emotional moderation, which are reflected in reports of less intense positive and negative emotional experiences (Eid & Diener, 2001; Russell & Yik, 1996).

This study examined whether neural reactivity to reward predicts depressive symptoms and tested whether race/ethnicity moderated this association. For trials with social incentives, it was predicted that the relation between reactivity to social reward and depressive symptoms would be more negative (i.e., more blunted response for those with greater depressive symptoms; stronger negative correlation) for Asian American adolescents than European American, due to the importance placed on social interaction in collectivistic culture. The data did not support this hypothesis. Diverging from the hypothesis, there was a trend towards significance for the P3 ×

race/ethnicity interaction, with European Americans showing a steeper positive relation between P3 amplitude and depression during social reward no-go trials with European American faces. As depression symptom count increased, European American participants found smiling European American faces to be more rewarding, as indicated by larger P3 amplitudes, during trials when they were asked to inhibit their response. This result conflicts with prior findings of depression being associated with blunted response to reward (Foti, Kotov, Klein, & Hajcak, 2011, Shankman, Klein, Tenke, & Bruder, 2007). This trend was not found with Asian American participants nor when participants were shown Asian faces. No main effects were found for race/ethnicity or P3 amplitude on any of the go and no-go trials.

Of interest is that P3 amplitude and depression were positively correlated. Other studies have found a similar pattern in young adults with major depressive disorder. Davey and colleagues (2011) demonstrated that depressed participants responded to positive social feedback with increased neural activation, perhaps due to heightened sensitivity to social evaluation. It could be that depressed participants within the current study were sensitive to the social feedback they experienced, thus leading to heightened P3 amplitude for correct responses (i.e., refrain from responding after a no-go cue). Also, the trend was only seen with European American participants. One thought for why we might see the P3 × race/ethnicity trend in only European American participants is due to the faces used in the experimental task. While the faces in the NimStim Face Stimulus Set represent a range of racial/ethnic diversity, validity and reliability of the stimulus set was tested on a mainly European American sample (Tottenham et al., 2009). It would be useful to assess whether the stimulus set is reliable and valid for use in other populations.

For monetary incentives, it was predicted that blunted P3 component would be associated with higher levels of depressive symptoms for both Asian and European American participants. Contrary to the hypothesis, there were no significant interactions or main effects for P3 amplitude and race/ethnicity. Although within-subject analyses of the different reward types revealed greater P3 amplitude towards monetary reward when compared to social and neutral rewards, P3 amplitude did not significantly predict depressive symptoms within this study. The interaction of P3 amplitude and race/ethnicity also did not significantly predict depressive symptoms. This was consistent for both go and no-go trials. It's possible that the participants in this study did not exhibit a large enough range of depressive symptoms on the YA-DISC-IV to see a significant relation between P3, race/ethnicity, and depression. It is worth noting that the YA-DISC-IV was not significantly correlated to any of the Phase Two P3 amplitudes or positive affect measures for either race/ethnicity. While Phase Two participants were recruited to represent a full range of depression on the PHQ-9, from minimal to severely depressed, only 3 participants met criteria for a major depressive episode within the last year on the YA-DISC-IV. Many of the participants endorsed numerous symptoms associated with a major depressive episode, but most did not report experiencing either depressed mood or anhedonia for at least two consecutive weeks. Including more clinically impaired participants would provide a larger range of depression and may lead to more significant associations between P3 amplitude and depression.

Another thought is the task may not have elicited a strong enough response. While the task did produce P3 amplitudes, there was not a significant difference between those who were more or less depressed. Varying task difficulty could facilitate sustained attention on the task and lead to heightened reward reactivity for correct responses. Pictures of money and unfamiliar

faces may also not be the most motivating stimuli. Utilizing pictures of familiar faces (e.g., family, friends, well-liked celebrities), using more dynamic stimuli, such as video clips, or simulated interaction with peers (Silk et al., 2012) may create a more natural, ecologically valid context for the task.

Significant racial/ethnic differences were not found for P3 amplitudes on any of the reward types. Beyond the issue of task validity, results may also imply that there are no biological racial/ethnic differences. This would be consistent with the core emotion system, which posits a biologically innate processing system for emotional states that is hard-wired and more difficult to modify by experience, including cultural experiences (Levenson, 1999). This system would expect universality in physiological response to an emotional experience. In line with this, studies have found no racial/ethnic differences in physiological response among Asian Americans and European Americans when exposed to an emotional event, including an amusing film clip (Chentsova et al., 2007; Tsai, Chentsova-Dutton, Freire-Bebeau, & Przymus, 2002). Given this, it is important to tease apart whether the lack of racial/ethnic difference is truly due to there not being a difference or if there are confounds with the experimental task.

This study also explored whether acculturation moderates the expression of positive affect and reward for Asian American adolescents. It was predicted that greater acculturation would magnify the negative association between self-reported positive affect and depression. With regards to reactivity towards reward, greater acculturation was predicted to dampen the relation (i.e., weaker negative correlation) between blunted response to social reward and depressive symptoms. Using the YA-DISC-IV, acculturation did not interact with positive affect or P3 amplitude to significantly predict depression. Retention of one's cultural identity was hypothesized to moderate the expression of reward, however enculturation also did not interact

with positive affect or P3 amplitude to significantly predict depression. Both acculturation and enculturation did not exhibit significant main effects in predicting depression.

Several studies examining positive affect, depression, and acculturation (using an acculturation measure instead of a proxy variable) have found acculturation as a moderator of positive affect (Jang et al., 2005; Kim et al., 2010; Leu et al., 2011). However it is of note that these studies used the Center for Epidemiological Studies – Depression Scale (CES-D; Radloff, 1977). Indeed, the results within this study were more consistent with results from previous studies when the CES-D was used as an outcome variable. Exploratory analyses revealed a significant main effect of acculturation when using the CES-D as an outcome. Acculturation was negatively related to depression, indicating low acculturation was associated with higher levels of depression. There was also a trend towards significance for the interaction of positive affect and enculturation in predicting depression on the CES-D. Those who retain higher levels of Asian culture have a less negative association between depression and positive affect. It is possible that the behaviors and beliefs assessed to measure acculturation and enculturation did not relate to the symptoms asked within the PHQ-9 (Spitzer, Kroenke, & Williams, 1999). The items within the PHQ-9 match directly to diagnostic criteria for a major depressive episode, whereas items on the CES-D assess for positive affect, negative affect, somatic symptoms, and interpersonal difficulties and may map on better to changes in cultural practices. Along those lines, both acculturation and enculturation are processes that change over time, yet data for these variables were only collected at one time point. Assessing these variables over time would provide more information on whether acculturation and enculturation moderate positive affect in predicting depression outside of the CES-D.

The present study has several strengths. First, it examined reward function in relation to depression during the adolescent developmental period. This may help place the etiology of adolescent depression within a context of overall changes in reward processing. In addition, research on reward function and depression has largely utilized tasks with monetary incentives. As depression greatly affects an individual's social functioning, it is imperative to investigate reward functioning within a social context. Second, an increasing number of studies acknowledge the importance of examining the role of culture in the expression of depression. However, few studies have looked specifically at culture and reward dysfunction, and even fewer have looked at these constructs during a developmental period when depression is emerging. In addition, collectivistic values commonly held in Asian cultures have been linked to greater sensitivity to social events (Way & Lieberman, 2010), thereby underscoring the importance of investigating responses in the context of social rewards. Finally, this study adopts a multimodal assessment approach, which combines self-report and physiological assessment and takes a systems framework in order to comprehensively understand how culture may impact the expression of reward function and depression.

It is important to acknowledge and address several limitations. Participants were 18 and 19 year-old students recruited from a college population, which may limit generalizability to other ages and education levels. Symptoms of depression often emerge during childhood and adolescence, and adolescent onset of depression is associated with social and academic impairment, risk of recurrent depressive episodes, substance use, and suicide (Emslie et al., 2008; Kovacs, 1996; Kovacs & Paulaukas, 1984; Weissman et al., 1999). These risks make it important to understand positive affect in a younger population and how it manifests cross-culturally for the best chances of early intervention. Because participants were all functioning

college students, that may also limit the range of depression within this study. During Phase One of the study, a subset of participants met criteria for severe depression on the PHQ-9, however, none hit the ceiling score (i.e., a score of 27) for the measure. In addition, Phase Two participants were recruited to represent a full range of depression based on the PHQ-9, but only 3 participants met criteria for a major depressive episode in the last year on the YA-DISC-IV. Future studies should make efforts to recruit a more clinically impaired sample to examine whether our results generalize beyond a college sample.

Although the present study has a substantial proportion of Asian American youth, the sample size is still not large enough to test potential Asian subgroup or generational differences. Future research should use a larger sample and examine potential Asian ethnic subgroup differences. Acculturation and enculturation did not significantly moderate positive affect or reward. Inclusion criteria for the study required participants to be able to speak and read English, limiting the potential range of acculturation and enculturation. Also, data on culture was only acquired at one time point, while acculturation and enculturation are processes that change over time. These issues should be addressed in future studies by broadening the inclusion criteria to include a wider range of participants and by collecting data longitudinally.

In addition, it may be fruitful to examine other cultural variables such as dialectic thinking. Bagozzi and colleagues (1999) provided evidence that traditionally opposing affects (e.g., happiness and sadness) are less negatively related in dialectic East Asian cultures than cultures without dialectic philosophies (e.g., North American countries). Future research should see whether a measure of dialectic thinking better predicts a weak negative correlation between positive affect and depression.

Only females were recruited for the second phase due to the lower prevalence of depression in males, and the exploratory nature of the research. Recruiting a larger mixed sample will allow for the examination of sex differences. Last, P3 amplitude was not significantly related to depression, race/ethnicity, or acculturation measures within this study. It will be important to determine whether the experimental task used elicited a strong enough reward response to detect group differences. As mentioned above, future studies could manipulate the difficulty of the task, incorporate dynamic stimuli (i.e., video clips), or utilize a peer interaction task, such as the Chatroom Interact Task (Silk et al., 2012), to create a more natural, ecologically valid context for the task.

Overall, psychology as a field is moving forward from examining whether psychological constructs relate, towards figuring out for whom do these constructs relate. Racial group comparisons are essential for understanding the nature of the relation between depression and positive affect. Better measurement and greater consideration of contextual factors may improve the accuracy of diagnosis and intervention among Asian populations. Historically, the examination of neural response has been useful in identifying adolescents at risk for depression (Foti, Kotov, Klein, & Hajcak, 2011) and differentiating response to reward in depressed versus non-depressed individuals (Shankman, Klein, Tenke, & Bruder, 2007). While the current findings suggest culture may shape subjective report of positive affect more than physiological expression, given the paucity of research on cultural neuroscience, it is important for future studies to continue exploring the sociocultural influences on physiological processes to better understand the emergence of depression amongst adolescents from different cultures. This study will contribute to the formulation of culturally sensitive theoretical models of emotion and the refinement of prevention and intervention programs for young adults experiencing depression.

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*Table 1. Phase One Descriptive Statistics (n = 825)*

| Variable | Race/Ethnicity | Sex | *M* | *SD* | Skew | Kurtosis | Range |
|---|---|---|---|---|---|---|---|
| **PHQ-9 Depression** | European American | Male | 3.65 | 3.79 | 1.95 | 5.06 | 0-21 |
| | | Female | 5.34 | 4.77 | 1.24 | 1.19 | 0-23 |
| | Asian American | Male | 5.65 | 4.57 | 1.17 | 0.74 | 0-18 |
| | | Female | 5.67 | 4.39 | 1.41 | 2.50 | 0-22 |
| **PANAS Positive Affect** | European American | Male | 24.94 | 7.19 | -0.37 | -0.02 | 2-40 |
| | | Female | 23.44 | 7.97 | -0.26 | -0.26 | 1-40 |
| | Asian American | Male | 20.10 | 7.37 | -0.01 | -0.13 | 0-38 |
| | | Female | 19.20 | 7.55 | 0.07 | -0.13 | 0-39 |
| **CES-D Depression** | European American | Male | 9.43 | 7.11 | 0.93 | 0.70 | 0-36 |
| | | Female | 11.90 | 9.44 | 1.13 | 0.53 | 0-41 |
| | Asian American | Male | 12.99 | 7.78 | 0.83 | 0.85 | 1-44 |
| | | Female | 13.51 | 8.16 | 1.09 | 1.46 | 0-46 |
| **AAMAS Acculturation** | Asian American | Male | 3.53 | 0.70 | -0.31 | -0.28 | 1.73-4.87 |
| | | Female | 3.57 | 0.70 | -0.40 | -0.11 | 1.07-5.00 |
| **AAMAS Enculturation** | Asian American | Male | 2.15 | 0.76 | 0.38 | 0.31 | 0.33-4.33 |
| | | Female | 2.28 | 0.88 | 0.35 | -0.27 | 0.33-4.80 |

*Table 2. Correlations (European American participants)*

| | 1. | 2. | 3. |
|---|---|---|---|
| **1. PHQ-9 Depression** | 1.00 | | |
| **2. PANAS Positive Affect** | -.48** | 1.00 | |
| **3. CES-D Depression** | .81** | -.61** | 1.00 |

*$p < .05$
**$p < .01$

*Table 3. Correlations (Asian American participants)*

| | 1. | 2. | 3. | 4. | 5. |
|---|---|---|---|---|---|
| **1. PHQ-9 Depression** | 1.00 | | | | |
| **2. PANAS Positive Affect** | -.31** | 1.00 | | | |
| **3. CES-D Depression** | .73** | -.42** | 1.00 | | |
| **4. AAMAS Acculturation** | -.13** | .31** | -.22** | 1.00 | |
| **5. AAMAS Enculturation** | .05 | -.01 | .10 | -.01 | 1.00 |

*$p < .05$
**$p < .01$

*Table 4. Phase One Mean Comparisons by Race/Ethnicity and Sex*

**All Participants**

| | European American | | Asian American | | |
|---|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* | *t*-test |
| **PHQ-9 Depression** | 4.75 | 4.51 | 5.68 | 4.44 | -2.98** |
| **CES-D Depression** | 11.05 | 8.77 | 13.38 | 8.02 | -3.97** |
| **PANAS Positive Affect** | 23.99 | 7.72 | 19.49 | 7.47 | 8.45** |

| | **Male Only** | | | | | **Female Only** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | European American | | Asian American | | | European American | | Asian American | | |
| | *M* | *SD* | *M* | *SD* | *t*-test | *M* | *SD* | *M* | *SD* | *t*-test |
| **PHQ-9 Depression** | 3.65 | 3.79 | 5.65 | 4.57 | -4.01** | 5.34 | 4.77 | 5.67 | 4.39 | *ns* |
| **CES-D Depression** | 9.43 | 7.11 | 11.90 | 9.44 | -4.04** | 12.99 | 7.78 | 13.51 | 8.16 | *-2.10** |
| **PANAS Positive Affect** | 24.94 | 7.19 | 20.10 | 7.37 | 5.60** | 23.44 | 19.20 | 19.20 | 7.55 | 6.29** |

*$p < .05$
** $p < .001$

*Table 5. Phase One Regression Analyses Examining Race/Ethnicity as a Moderator (n = 825)*

| | *b* | SE | *β* | *p* |
|---|---|---|---|---|
| **Intercept** | 12.60 | 1.49 | | < .001 |
| **Sex** | 0.64 | 0.28 | 0.07 | .02 |
| **Positive Affect (PA)** | -0.38 | 0.06 | -0.66 | < .001 |
| **Race/Ethnicity** | -2.23 | 0.86 | -0.25 | .01 |
| **PA × Race/Ethnicity** | 0.10 | 0.04 | 0.30 | .01 |

*Table 6. Phase Two Descriptive Statistics (n = 68)*

| **Variable** | Race/Ethnicity | *M* | *SD* | Skew | Kurtosis | Range |
|---|---|---|---|---|---|---|
| **PHQ-9 Depression** | European American | 8.15 | 4.70 | 0.32 | -0.71 | 1-18 |
| | Asian American | 7.80 | 5.15 | 0.80 | 0.42 | 0-21 |
| **YA-DISC-IV Depression Symptom Count** | European American | 11.27 | 4.40 | -0.26 | -0.92 | 3-19 |
| | Asian American | 10.11 | 3.83 | -0.13 | -0.68 | 2-17 |
| **Pre-EEG PANAS PA** | European American | 18.27 | 7.31 | -0.20 | -0.15 | 4-35 |
| | Asian American | 16.29 | 6.66 | -0.03 | -0.53 | 3-31 |
| **Post-EEG PANAS PA** | European American | 17.52 | 9.11 | 0.20 | -0.86 | 3-36 |
| | Asian American | 13.66 | 8.04 | 0.58 | -0.44 | 2-32 |
| **AAMAS Acculturation** | Asian American | 3.88 | 0.63 | -0.50 | -0.84 | 2.67 – 4.73 |
| **AAMAS Enculturation** | Asian American | 2.37 | 0.88 | 0.46 | -0.15 | 0.79 – 4.67 |
| ***Cz Electrode Site*** | Race/Ethnicity | *M* | *SD* | Skew | Kurtosis | Range |
| **P3 Social Reward (Asian Faces) – Go Trials** | European American | 0.30 | 4.15 | 0.27 | 0.59 | -8.31 – 11.24 |
| | Asian American | -0.81 | 3.67 | 0.30 | 1.44 | -9.54 – 9.48 |
| **P3 Social Reward (Asian Faces) – No-Go Trials** | European American | -0.61 | 4.57 | 0.08 | -0.54 | -9.26 – 8.19 |
| | Asian American | 0.55 | 6.34 | 0.13 | -0.16 | -12.21 – 14.98 |
| **P3 Social Reward (EA Faces) – Go Trials** | European American | 1.56 | 4.25 | 0.75 | 3.27 | -7.94 – 15.89 |
| | Asian American | -0.18 | 5.29 | 1.42 | 5.55 | -10.47 – 20.25 |
| **P3 Social Reward (EA Faces) – No-Go Trials** | European American | -0.03 | 5.08 | 0.13 | -0.92 | -8.65 – 8.92 |
| | Asian American | -1.64 | 4.42 | 0.01 | -0.46 | -10.42 – 7.87 |
| **P3 Monetary Reward – Go Trials** | European American | 3.43 | 3.98 | 0.24 | 0.81 | -3.80 – 14.55 |
| | Asian American | 1.65 | 4.69 | 1.02 | 1.16 | -6.11 – 16.01 |
| **P3 Monetary Reward – No-Go Trials** | European American | 2.98 | 3.90 | -0.37 | -0.82 | -4.69 – 8.82 |
| | Asian American | 1.72 | 5.70 | 0.63 | 0.52 | -0.05 – 16.50 |
| **P3 Neutral Reward – Go Trials** | European American | 0.90 | 3.52 | 0.35 | 0.56 | -6.26 – 9.66 |
| | Asian American | 0.55 | 4.58 | 2.40 | 8.16 | -5.62 – 19.50 |
| **P3 Neutral Reward – No-Go Trials** | European American | 0.85 | 3.24 | 0.06 | -0.14 | -6.86 – 7.16 |
| | Asian American | -0.10 | 3.86 | 0.88 | 2.23 | -6.77 – 12.64 |
| ***Pz Electrode Site*** | Race/Ethnicity | *M* | *SD* | Skew | Kurtosis | Range |
| **P3 Social Reward (Asian Faces) –** | European American | 4.20 | 4.38 | -0.24 | 1.31 | -8.37 – 13.62 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Go Trials** | | | | | | |
| | Asian American | 2.56 | 3.84 | 0.81 | 2.10 | -3.89 – 15.26 |
| **P3 Social Reward (Asian Faces) – No-Go Trials** | European American | 3.53 | 4.76 | -0.58 | 1.16 | -10.28 – 13.29 |
| | Asian American | 3.79 | 6.35 | 0.22 | -0.54 | -9.19 – 16.99 |
| **P3 Social Reward (EA Faces) – Go Trials** | European American | 5.07 | 4.34 | -0.28 | 3.51 | -8.43 – 17.48 |
| | Asian American | 3.02 | 5.08 | 1.38 | 5.07 | -7.30 – 22.24 |
| **P3 Social Reward (EA Faces) – No-Go Trials** | European American | 3.84 | 5.09 | -0.05 | -0.42 | -6.33 – 13.46 |
| | Asian American | 3.12 | 5.53 | 1.54 | 4.09 | -5.49 – 23.32 |
| **P3 Monetary Reward – Go Trials** | European American | 6.40 | 4.12 | 0.17 | 1.25 | -2.38 – 18.14 |
| | Asian American | 5.02 | 4.92 | 0.92 | 1.12 | -3.54 – 19.86 |
| **P3 Monetary Reward – No-Go Trials** | European American | 6.10 | 3.28 | -0.57 | -0.35 | -1.60 – 11.44 |
| | Asian American | 5.46 | 5.74 | 0.86 | 1.47 | -4.74 – 23.11 |
| **P3 Neutral Reward – Go Trials** | European American | 3.37 | 3.65 | 0.44 | 0.19 | -2.70 – 11.59 |
| | Asian American | 2.97 | 4.88 | 2.00 | 5.65 | -2.93 – 21.79 |
| **P3 Neutral Reward – No-Go Trials** | European American | 3.40 | 3.38 | -0.43 | 1.15 | -6.74 – 9.68 |
| | Asian American | 2.80 | 4.29 | 1.15 | 2.91 | -5.36 – 17.46 |

*Table 7. Correlations (Cz electrode site, European American participants)*

| | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1. YA-DISC-IV Symptom Count** | 1.00 | | | | | | | | | | |
| **2. Pre-EEG PANAS Positive Affect** | -.06 | 1.00 | | | | | | | | | |
| **3. Post-EEG PANAS Positive Affect** | -.03 | .76** | 1.00 | | | | | | | | |
| **4. P3 Social Reward (Asian Faces) – Go Trials** | .16 | .35* | .33 | 1.00 | | | | | | | |
| **5. P3 Social Reward (Asian Faces) – No-Go Trials** | .13 | -.07 | -.07 | .36* | 1.00 | | | | | | |
| **6. P3 Social Reward (EA Faces) – Go Trials** | -.06 | .17 | .14 | .62* | .46** | 1.00 | | | | | |
| **7. P3 Social Reward (EA Faces) – No-Go Trials** | .30 | .20 | .20 | .46** | .68** | .47** | 1.00 | | | | |
| **8. P3 Monetary Reward – Go Trials** | .17 | .35* | .26 | .72** | .25 | .61** | .48** | 1.00 | | | |
| **9. P3 Monetary Reward – No-Go Trials** | .20 | .23 | .18 | .43* | .42* | .47** | .42* | .55** | 1.00 | | |
| **10. P3 Neutral Reward – Go Trials** | .19 | .38* | .37* | .53** | .28 | .64** | .50** | .72** | .52** | 1.00 | |
| **11. P3 Neutral Reward – No-Go Trials** | .30 | .10 | .08 | .39* | .52** | .42* | .59** | .45** | .61** | .62** | 1.00 |

*$*p < .05$*
*$**p < .01$*

*Table 8. Correlations (Cz electrode site, Asian American participants)*

| | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1. YA-DISC-IV Symptom Count** | 1.00 | | | | | | | | | | |
| **2. Pre-EEG PANAS Positive Affect** | .05 | 1.00 | | | | | | | | | |
| **3. Post-EEG PANAS Positive Affect** | .002 | .71** | 1.00 | | | | | | | | |
| **4. P3 Social Reward (Asian Faces) – Go Trials** | -.05 | .34* | .13 | 1.00 | | | | | | | |
| **5. P3 Social Reward (Asian Faces) – No-Go Trials** | -.20 | .48** | .31 | .56** | 1.00 | | | | | | |
| **6. P3 Social Reward (EA Faces) – Go Trials** | .005 | .29 | .17 | .69** | .43** | 1.00 | | | | | |
| **7. P3 Social Reward (EA Faces) – No-Go Trials** | -.12 | .16 | -.07 | .60** | .42* | .52** | 1.00 | | | | |
| **8. P3 Monetary Reward – Go Trials** | .15 | .57** | .27 | .68** | .42* | .62** | .54** | 1.00 | | | |
| **9. P3 Monetary Reward – No-Go Trials** | .08 | .37* | .03 | .59** | .25 | .49** | .73** | .79** | 1.00 | | |
| **10. P3 Neutral Reward – Go Trials** | .007 | .38* | .11 | .65** | .49** | .76** | .57** | .77** | .69** | 1.00 | |
| **11. P3 Neutral Reward – No-Go Trials** | .07 | .28 | .13 | .49** | .34* | .53** | .55** | .69** | .63** | .73** | 1.00 |

**p < .05*
***p < .01*

*Table 9. Correlations (Pz electrode site, European American participants)*

| | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1. YA-DISC-IV Symptom Count** | 1.00 | | | | | | | | | | |
| **2. Pre-EEG PANAS Positive Affect** | -.08 | 1.00 | | | | | | | | | |
| **3. Post-EEG PANAS Positive Affect** | .15 | .78** | 1.00 | | | | | | | | |
| **4. P3 Social Reward (Asian Faces) – Go Trials** | .03 | .10 | .03 | 1.00 | | | | | | | |
| **5. P3 Social Reward (Asian Faces) – No-Go Trials** | .11 | .28 | .45** | .38* | 1.00 | | | | | | |
| **6. P3 Social Reward (EA Faces) – Go Trials** | -.06 | .46** | .45** | .57** | .55** | 1.00 | | | | | |
| **7. P3 Social Reward (EA Faces) – No-Go Trials** | .14 | .50** | .49** | .47** | .67** | .59** | 1.00 | | | | |
| **8. P3 Monetary Reward – Go Trials** | .21 | .30 | .18 | .70** | .21 | .57** | .55** | 1.00 | | | |
| **9. P3 Monetary Reward – No-Go Trials** | .08 | .19 | .10 | .46** | .34 | .56** | .40* | .43* | 1.00 | | |
| **10. P3 Neutral Reward – Go Trials** | .23 | .33 | .22 | .46** | .10 | .53** | .42* | .72** | .37* | 1.00 | |
| **11. P3 Neutral Reward – No-Go Trials** | .11 | .24 | .16 | .31 | .47** | .45** | .57** | .31 | .47** | .49** | 1.00 |

*$p < .05$
**$p < .01$

*Table 10. Correlations (Pz electrode site, Asian American participants)*

| | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1. YA-DISC-IV Symptom Count** | 1.00 | | | | | | | | | | |
| **2. Pre-EEG PANAS Positive Affect** | .11 | 1.00 | | | | | | | | | |
| **3. Post-EEG PANAS Positive Affect** | .16 | .72** | 1.00 | | | | | | | | |
| **4. P3 Social Reward (Asian Faces) – Go Trials** | -.02 | -.07 | .19 | 1.00 | | | | | | | |
| **5. P3 Social Reward (Asian Faces) – No-Go Trials** | -.12 | -.26 | -.33 | .42 | 1.00 | | | | | | |
| **6. P3 Social Reward (EA Faces) – Go Trials** | .10 | -.03 | .10 | .75** | .36* | 1.00 | | | | | |
| **7. P3 Social Reward (EA Faces) – No-Go Trials** | .01 | -.30 | -.22 | .57** | .40* | .49** | 1.00 | | | | |
| **8. P3 Monetary Reward – Go Trials** | .21 | -.21 | -.03 | .62** | .36* | .60** | .58** | 1.00 | | | |
| **9. P3 Monetary Reward – No-Go Trials** | .06 | -.14 | -.19 | .53** | .30 | .51** | .60** | .78** | 1.00 | | |
| **10. P3 Neutral Reward – Go Trials** | .08 | -.17 | -.02 | .63** | .41* | .74** | .48** | .78** | .71** | 1.00 | |
| **11. P3 Neutral Reward – No-Go Trials** | .06 | -.10 | .07 | .55** | .33 | .59** | .46** | .78** | .67** | .79** | 1.00 |

*$p < .05$
**$p < .01$

*Table 11. Correlations (Cz and Pz electrode sites, European American participants)*

| | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1. P3 Social Reward – Go Trials, Cz electrode** | 1.00 | | | | | | | | | | | |
| **2. P3 Social Reward – Go Trials, Pz electrode** | .87** | 1.00 | | | | | | | | | | |
| **3. P3 Social Reward – No-Go Trials, Cz electrode** | .53** | .52** | 1.00 | | | | | | | | | |
| **4. P3 Social Reward – No-Go Trials, Pz electrode** | .47** | .62** | .90** | 1.00 | | | | | | | | |
| **5. P3 Monetary Reward – Go Trials, Cz electrode** | .74** | .64** | .40* | .35* | 1.00 | | | | | | | |
| **6. P3 Monetary Reward – Go Trials, Pz electrode** | .72** | .72** | .40* | .44* | .94** | 1.00 | | | | | | |
| **7. P3 Monetary Reward – No-Go Trials, Cz electrode** | .50** | .46** | .46** | .40* | .55** | .45** | 1.00 | | | | | |
| **8. P3 Monetary Reward – No-Go Trials, Pz electrode** | .51** | .58** | .36* | .41* | .45** | .43* | .86** | 1.00 | | | | |
| **9. P3 Neutral Reward – Go Trials, Cz electrode** | .65** | .50** | .43* | .30 | .72** | .69** | .52** | .39* | 1.00 | | | |
| **10. P3 Neutral Reward – Go Trials, Pz electrode** | .60** | .55** | .34 | .30 | .64** | .72** | .40* | .37* | .91** | 1.00 | | |
| **11. P3 Neutral Reward – No-Go Trials, Cz elecrtode** | .45** | .36* | .61** | .52** | .45** | .41* | .61** | .49** | .62** | .51** | 1.00 | |
| **12. P3 Neutral Reward – No-Go Trials, Pz elecrtode** | .32 | .43* | .49** | .57** | .21 | .31 | .41* | .47** | .46** | .49** | .84** | 1.00 |

*$p < .05$
**$p < .01$

*Table 12. Correlations (Cz and Pz electrode sites, Asian American participants)*

| | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1. P3 Social Reward – Go Trials, Cz electrode** | 1.00 | | | | | | | | | | | |
| **2. P3 Social Reward – Go Trials, Pz electrode** | .90** | 1.00 | | | | | | | | | | |
| **3. P3 Social Reward – No-Go Trials, Cz electrode** | .66** | .52** | 1.00 | | | | | | | | | |
| **4. P3 Social Reward – No-Go Trials, Pz electrode** | .65** | .59** | .85** | 1.00 | | | | | | | | |
| **5. P3 Monetary Reward – Go Trials, Cz electrode** | .70** | .66** | .55** | .64** | 1.00 | | | | | | | |
| **6. P3 Monetary Reward – Go Trials, Pz electrode** | .59** | .65** | .36* | .55** | .93** | 1.00 | | | | | | |
| **7. P3 Monetary Reward – No-Go Trials, Cz electrode** | .57** | .52** | .53** | .65** | .79** | .70** | 1.00 | | | | | |
| **8. P3 Monetary Reward – No-Go Trials, Pz electrode** | .50** | .55** | .37* | .53** | .76** | .78** | .89** | 1.00 | | | | |
| **9. P3 Neutral Reward – Go Trials, Cz electrode** | .78** | .75** | .62** | .63** | .77** | .71** | .69** | .72** | 1.00 | | | |
| **10. P3 Neutral Reward – Go Trials, Pz electrode** | .63** | .73** | .41* | .53** | .71** | .78** | .58** | .71** | .90** | 1.00 | | |
| **11. P3 Neutral Reward – No-Go Trials, Cz elecrtode** | .56** | .63** | .50** | .51** | .69** | .72** | .63** | .66** | .73** | .74** | 1.00 | |
| **12. P3 Neutral Reward – No-Go Trials, Pz elecrtode** | .48** | .61** | .33 | .46** | .66** | .78** | .55** | .67** | .67** | .79** | .93** | 1.00 |

**p < .05*
***p < .01*

*Table 13. Phase Two Mean Comparisons by Race/Ethnicity*

| | European American (n = 33) | | Asian American (n = 35) | | |
|---|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* | *p*-value |
| **YA-DISC-IV Symptom Count** | 11.27 | 4.40 | 10.11 | 3.83 | *ns* |
| **Pre-EEG PANAS Positive Affect** | 18.27 | 7.31 | 16.29 | 6.66 | *ns* |
| **Post-EEG PANAS Positive Affect** | 17.52 | 9.11 | 13.66 | 8.04 | .07 |
| ***Cz Electrode Site*** | | | | | |
| **P3 Social Reward (Asian Faces) – Go Trials** | 0.30 | 4.15 | -0.81 | 3.67 | *ns* |
| **P3 Social Reward (Asian Faces) – No-Go Trials** | -0.61 | 4.57 | 0.55 | 6.34 | *ns* |
| **P3 Social Reward (EA Faces) – Go Trials** | 1.56 | 4.25 | -0.18 | 5.29 | *ns* |
| **P3 Social Reward (EA Faces) – No-Go Trials** | -0.03 | 5.08 | -1.64 | 4.42 | *ns* |
| **P3 Monetary Reward – Go Trials** | 3.43 | 3.98 | 1.65 | 4.69 | .10 |
| **P3 Monetary Reward – No-Go Trials** | 2.98 | 3.90 | 1.72 | 5.70 | *ns* |
| **P3 Neutral Reward – Go Trials** | 0.90 | 3.52 | 0.55 | 4.58 | *ns* |
| **P3 Neutral Reward – No-Go Trials** | 0.85 | 3.24 | -0.10 | 3.86 | *ns* |
| ***Pz Electrode Site*** | | | | | |
| **P3 Social Reward (Asian Faces) – Go Trials** | 4.20 | 4.38 | 2.56 | 3.84 | .10 |
| **P3 Social Reward (Asian Faces) – No-Go Trials** | 3.53 | 4.76 | 3.79 | 6.35 | *ns* |
| **P3 Social Reward (EA Faces) – Go** | 5.07 | 4.34 | 3.02 | 5.08 | .08 |

| | | | | | |
|---|---|---|---|---|---|
| **Trials** | | | | | |
| **P3 Social Reward (EA Faces) – No-Go Trials** | 3.84 | 5.09 | 3.12 | 5.53 | *ns* |
| **P3 Monetary Reward – Go Trials** | 6.40 | 4.12 | 5.02 | 4.92 | *ns* |
| **P3 Monetary Reward – No-Go Trials** | 6.10 | 3.28 | 5.46 | 5.74 | *ns* |
| **P3 Neutral Reward – Go Trials** | 3.37 | 3.65 | 2.97 | 4.88 | *ns* |
| **P3 Neutral Reward – No-Go Trials** | 3.40 | 3.38 | 2.80 | 4.29 | *ns* |

*Table 14. Within-Subjects Differences on P3 Amplitude*

| | | Type III Sum of Squares | F | *p* |
|---|---|---|---|---|
| **Reward Type** | Linear | 40.01 | 1.25 | .27 |
| | Quadratic | 469.60 | 29.43 | P < .001 |
| **Reward Type × Race/Ethnicity** | Linear | 17.16 | 0.54 | .47 |
| | Quadratic | 2.99 | 0.19 | .67 |
| **Go/No-Go Trial** | Linear | 38.36 | 2.06 | .16 |
| **Go/No-Go Trial × Race/Ethnicity** | Linear | 14.95 | 0.80 | .37 |
| **Reward Type × Go/No-Go** | Linear | 15.31 | 1.13 | .29 |
| | Quadratic | 9.20 | 1.12 | .29 |
| **Reward Type × Go/No-Go × Race/Ethnicity** | Linear | 37.99 | 2.79 | .10 |
| | Quadratic | 0.77 | 0.09 | .76 |

*Table 15. Phase Two Regression Analyses Examining Race/Ethnicity as a Moderator (n = 68)*

| | *b* | SE | *B* | *p* |
|---|---|---|---|---|
| **Intercept** | 12.62 | 1.60 | | < .001 |
| **P3 Social Reward (EA Faces) – No-Go Trials** | 0.62 | 0.32 | 0.72 | .06 |
| **Race/Ethnicity** | -1.34 | 1.02 | -0.16 | .19 |
| **P3 × Race/Ethnicity** | -0.36 | 0.21 | -0.65 | .09 |

*Table 16. Regression Analyses Examining Race/Ethnicity as a Moderator with CES-D Depression Outcome (n = 825)*

| | *b* | SE | *B* | *p* |
|---|---|---|---|---|
| **Intercept** | 10.82 | 0.89 | | < .001 |
| **Positive Affect (PA)** | -0.68 | 0.04 | -.64 | < .001 |
| **Race/Ethnicity** | -0.21 | 0.52 | -0.01 | .68 |
| **PA × Race/Ethnicity** | 0.24 | 0.07 | 0.15 | < .001 |

*Table 17. Regression Analyses Examining Acculturation as a Moderator with CES-D Depression Outcome (n = 388)*

| | *b* | SE | *B* | *p* |
|---|---|---|---|---|
| **Intercept** | 11.65 | 1.25 | | < .001 |
| **Positive Affect** | -0.42 | 0.05 | -0.39 | < .001 |
| **AAMAS Acculturation** | -1.10 | 0.55 | -0.10 | .05 |

*Table 18. Regression Analyses Examining Enculturation as a Moderator with CES-D Depression Outcome (n = 388)*

| | *b* | SE | *B* | *p* |
|---|---|---|---|---|
| **Intercept** | 11.75 | 1.24 | | < .001 |
| **Positive Affect (PA)** | -0.45 | 0.05 | -0.42 | < .001 |
| **AAMAS Enculturation** | 1.16 | 0.47 | 0.12 | .01 |
| **P3 × Enculturation** | 0.12 | 0.06 | 0.09 | .06 |

*Table 19. Regression Analyses Examining Main Effect of Social Reward on CES-D Depression Outcome (n = 68)*

| | *b* | SE | *B* | *p* |
|---|---|---|---|---|
| **Intercept** | 8.39 | 0.84 | | < .001 |
| **P3 Social Reward (EA Faces) – Go Trials** | -0.27 | 0.12 | -0.26 | .03 |
| **Race/Ethnicity** | -0.81 | 1.19 | -0.08 | .50 |

*Figure 1.Study Hypotheses and Specific Aims*

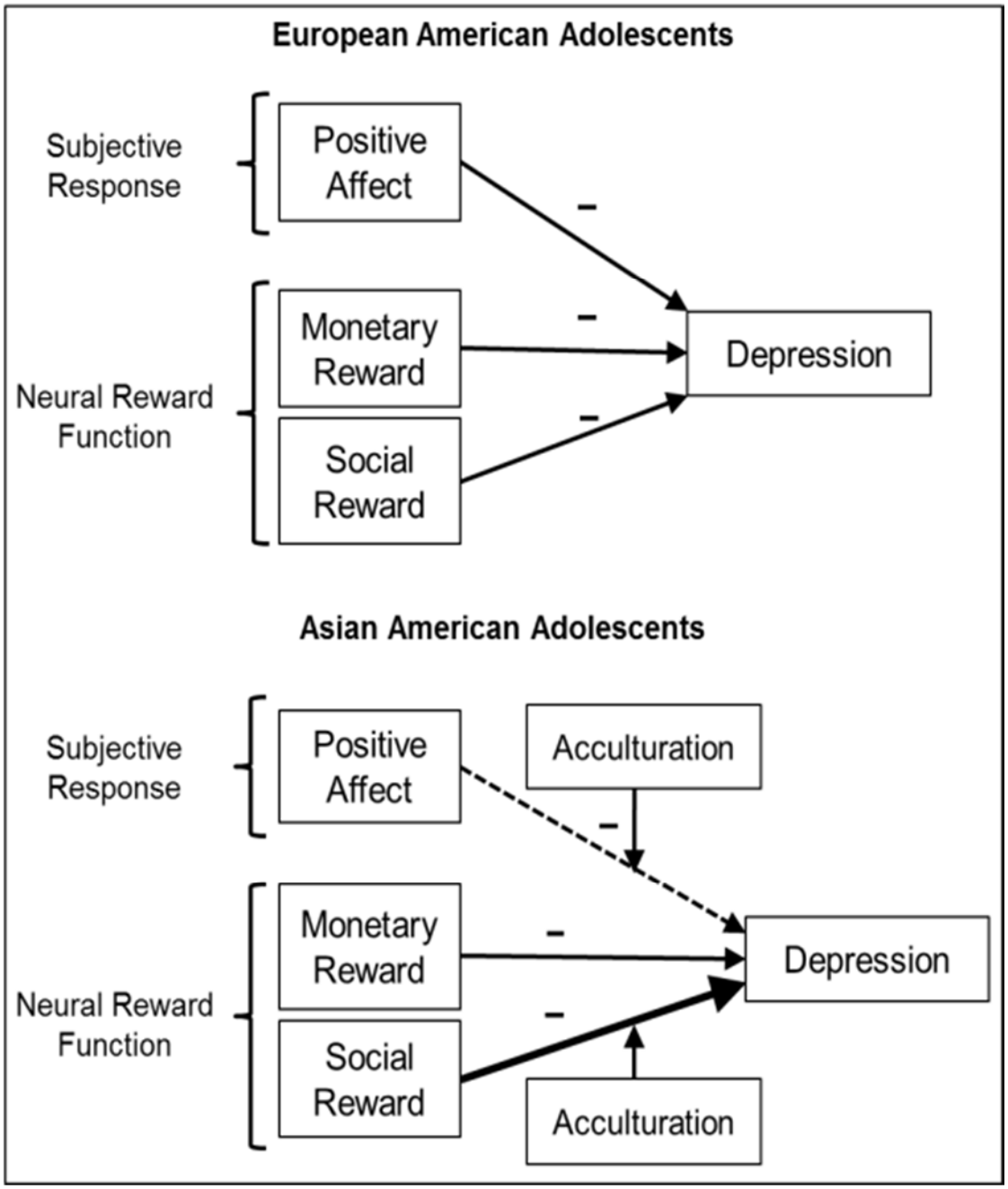

*Figure 2 Illustration of the cued incentive go/no-go task including three different incentive conditions: non-reward, monetary reward, and social reward.*

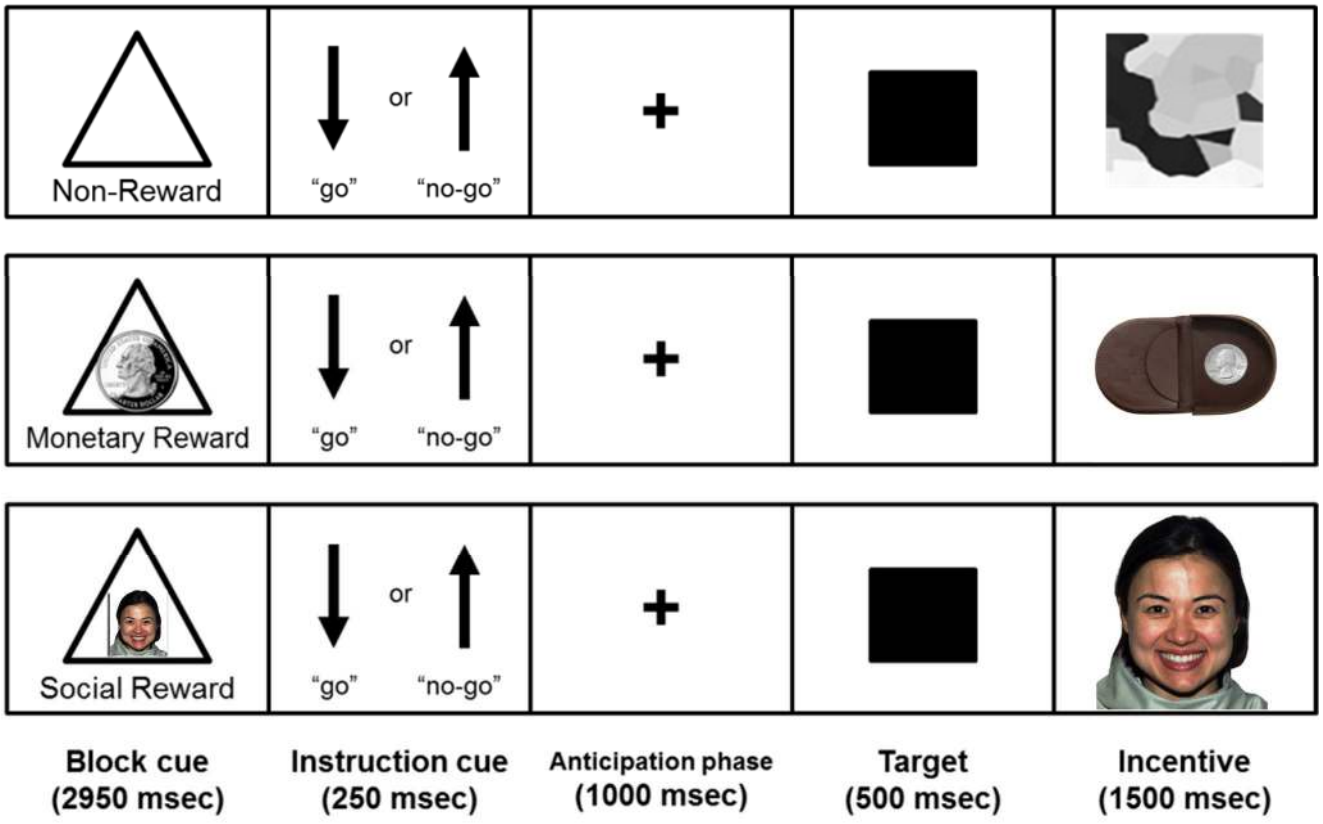

*Figure 3. Phase One Positive Affect × Race/Ethnicity Predicting Depression*

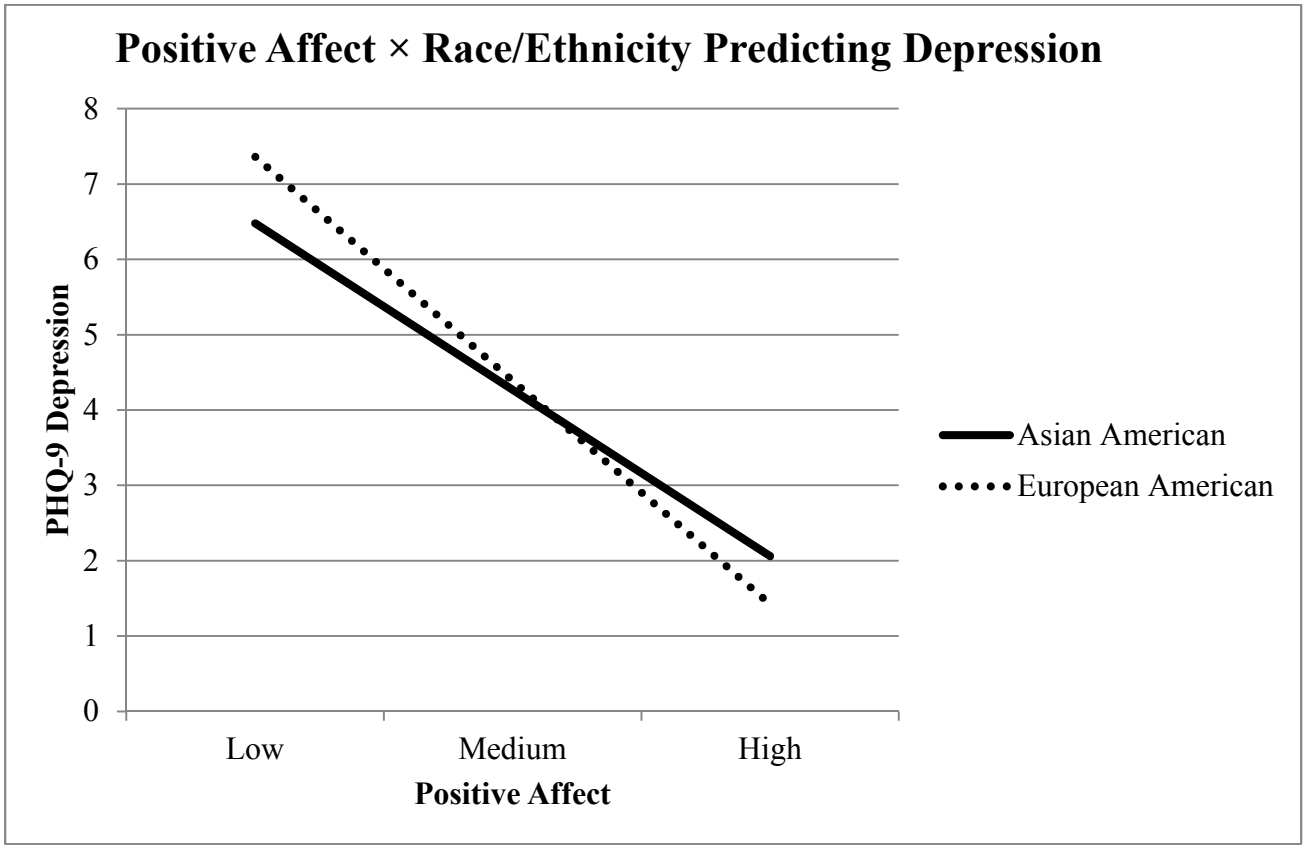

*Figure 4. Average P3 Amplitude by Reward Type*

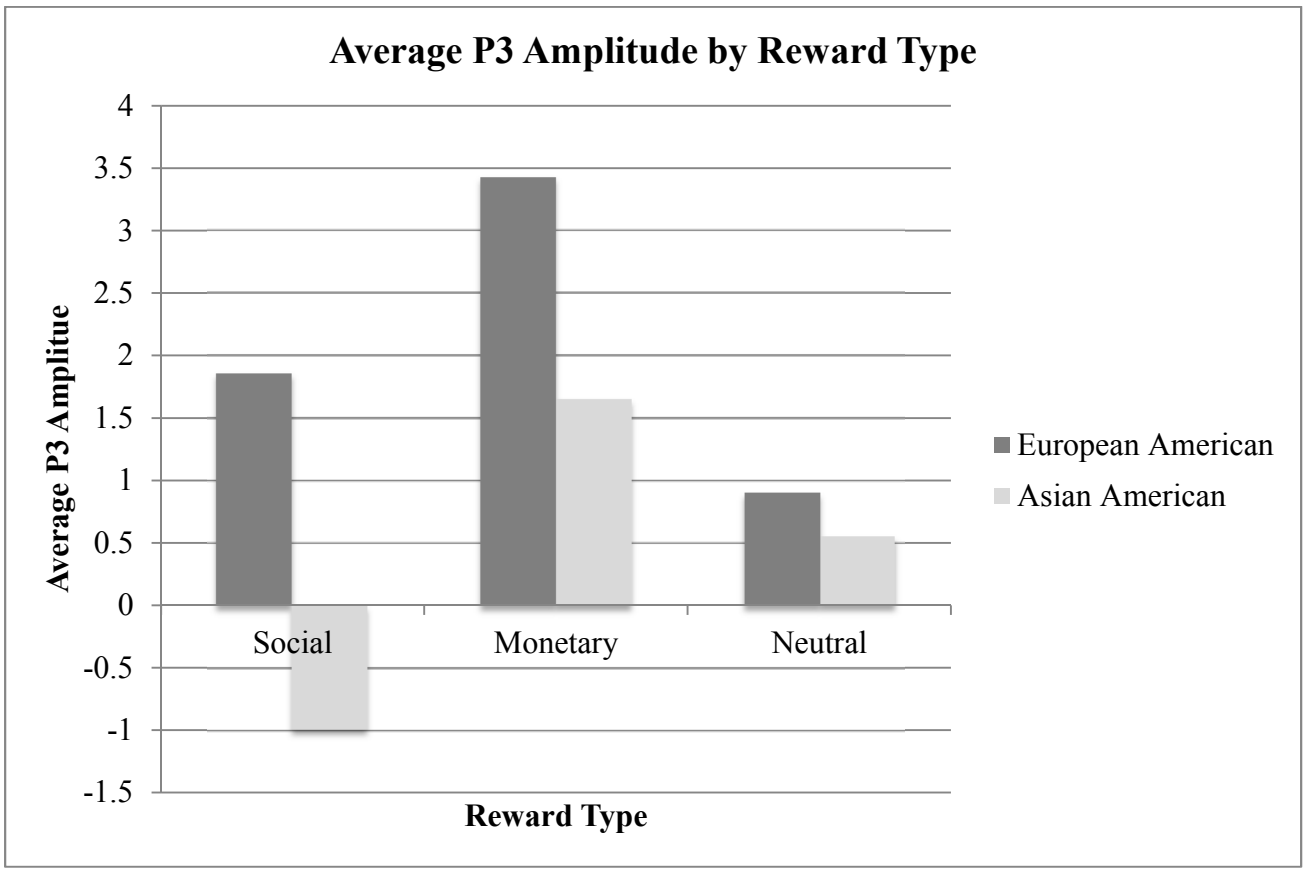

*Figure 5. Phase Two Social Reward P3 Amplitude × Race/Ethnicity Trend*

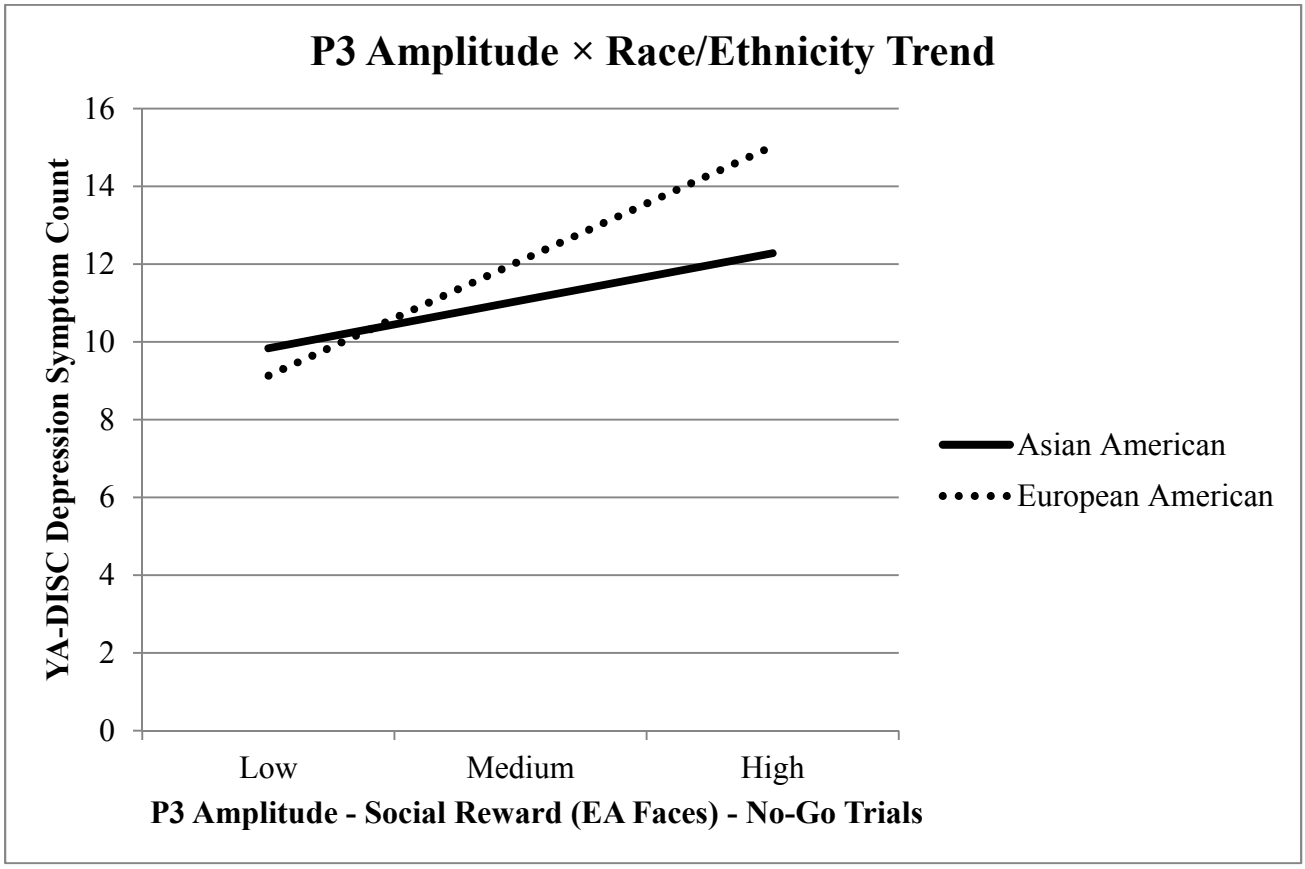

*Figure 6. Positive Affect × Race/Ethnicity Predicting CES-D Depression*

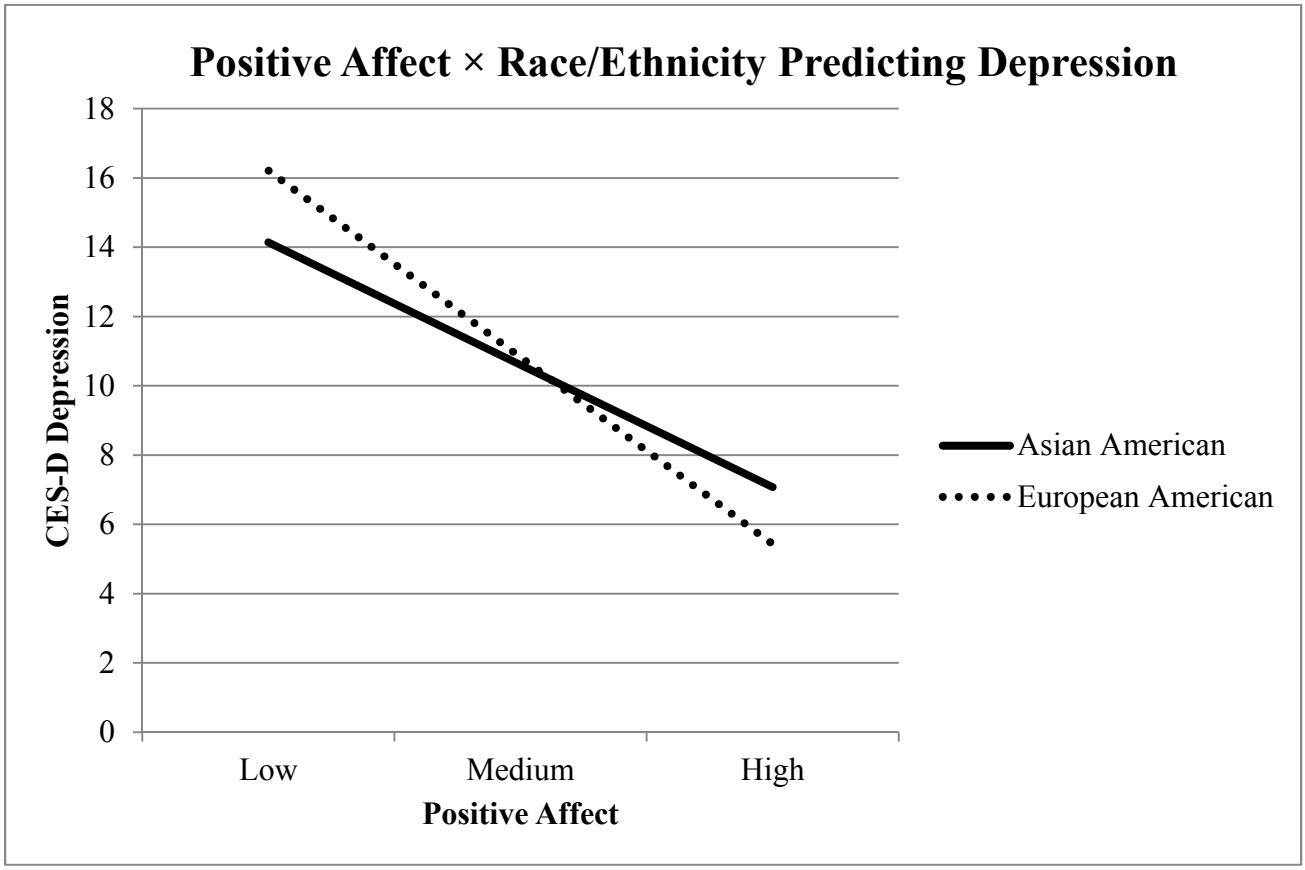

*Figure 7. Positive Affect × Enculturation Trend Predicting CES-D Depression*