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ORIGINAL RESEARCH ARTICLE

Ventral striatal activity mediates cultural differences in affiliative judgments of smiles

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Abstract Previous research demonstrates that European Americans judge excited (vs. calm) smiles as more affiliative (warm, friendly, extraverted) than do Chinese, and that these differences are in part due to European Americans valuing excitement, enthusiasm, and other high arousal positive states (HAP) more than Chinese. But what mechanisms underlie these differences? To answer this question, European Americans (n = 19) and Chinese (n = 19) viewed excited (vs. calm) targets and then rated targets' leadership potential (or familiarity, as a control) while undergoing functional magnetic resonance imaging. After scanning, participants then rated the same targets in terms of basic social traits such as affiliation, dominance, and competence. Consistent with previous findings, European Americans rated excited (vs. calm) targets as more affiliative than did Chinese. As predicted, European Americans showed greater ventral striatal activity (VS; associated with anticipation of reward) as they began to rate the excited (vs. calm) targets than did Chinese, and cultural differences in affiliation judgments were mediated by these cultural differences in VS activity (but not by activity in the medial prefrontal cortex, insula, or amygdala). However, while the cultural difference in affiliation judgments was driven by European Americans rating the excited (vs. calm) targets as more affiliative; the cultural difference in VS activity was driven by the calm (vs.

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excited) targets eliciting greater VS activity among Chinese, which more closely matched the cultural differences in ideal affect observed in this sample. Consistent with Affect Valuation Theory, these findings suggest that affective responses mediate cultural differences in affiliative judgments.

Keywords Culture · Neuroscience · Ventral striatum · Smiles · Ideal affect

Introduction

When people meet for the first time, they often automatically judge the warmth, friendliness, and extraversion (i.e., the affiliation) of their partners based on their partners' emotional expression and other characteristics of the face (e.g., Knutson 1996; Oosterhof and Todorov 2008). Individuals (or "judges") further infer that these judgments reflect stable traits of their partners (or "targets"). Based on Affect Valuation Theory (AVT), however, recent research suggests that these judgments may reveal as much about judges as they do about targets. For instance, judges who value affective states characterized by high arousal and positive valence (or HAP) such as excitement and enthusiasm rate targets with open, toothy ("excited") versus closed "calm" smiles as more affiliative (Tsai et al. in press). Moreover, cultural differences in the valuation of HAP are related to cultural differences in the degree to which targets with excited expressions are judged as affiliative. Specifically, European Americans rate excited (vs. calm) faces as more affiliative than Hong Kong Chinese do—regardless of the target's race (White, Asian) or sex (male, female)—and this effect is attributable to European Americans' greater valuation of HAP compared to Hong Kong Chinese (Tsai et al. in press). Interestingly, individuals' valuation of HAP is not as consistently related to judgments of dominance or competence, suggesting that people's "ideal affect" (i.e., the affective states they value and ideally want to feel) may particularly shape affiliative judgments. Since AVT predicts that cultural factors shape individuals' ideal affect more than their actual affect (or actual affective experience), and predicts that individuals' ideal affect can shape everyday choices and preferences, these findings extend AVT into the interpersonal realm of social judgment (Tsai 2007, 2017). Moreover, these findings raise the possibility that judges are unconsciously biased toward targets whose expressions match their ideal affect (or show an "ideal affect match").

The psychological mechanisms underlying cultural differences in affiliative judgments, however, remain unclear. Here, we used fMRI to test several possibilities based on a framework that infers mental states from activity in different brain regions (Knutson et al. 2014). This approach not only allows researchers to assess multiple candidate mechanisms simultaneously as participants make affiliative judgments, but it also enables them to track rapid and implicit psychological processes that participants may not be able to articulate in traditional behavioral measurements.

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Possible mechanisms

Based on previous empirical findings, we examined three possible mechanisms. First, European Americans might rate excited (vs. calm) faces as more affiliative than Chinese do because they find excited (vs. calm) faces *more rewarding* or because they experience *more high arousal positive affect* when they view excited (vs. calm) faces. Supporting this notion, previous studies showed that judges form more favorable impressions about targets when they feel positive affect (Forgas 1992; Forgas and Bower 1987; Schwarz 1990). This implies that European Americans might show greater activity in the ventral striatum (a brain region associated with anticipation of reward and high arousal positive affect; for reviews, see Knutson and Greer 2008; Knutson et al. 2014) than Chinese when viewing excited (vs. calm) smiles. This in turn could be associated with cultural differences in affiliative judgments of excited (vs. calm) smiles.

Second, it is possible that European Americans rate excited (vs. calm) faces as more affiliative because they *identify more with* excited (vs. calm) faces or find them *more self-relevant*. For example, previous studies found that people favor others who are more similar to themselves (Condon and Crano 1988; Sole et al. 1975). Self-related processing is associated with increased activity in the medial prefrontal cortex (MPFC; see http://www.neurosynth.org/analyses/terms/self/; Denny et al. 2012; Rameson et al. 2010; Zhu et al. 2007), a region that also integrates and computes value (Knutson et al. 2005). This implies not only that European Americans should show greater MPFC activity than Chinese when viewing excited (vs. calm) smiles, reflecting greater self-relevance and/or greater value computation, but also that cultural differences in MPFC activity could be associated with cultural differences in affiliative judgments of excited (vs. calm) smiles.

Finally, the experience of negative affect, reflected by anterior insula and amygdala activity (Barrett et al. 2007; Chiao et al. 2008; Knutson et al. 2014; Paulus and Stein 2006; Wager and Barrett 2004), has been associated with avoidance behavior (Knutson and Greer 2008) and negative evaluations of others (Abelson et al. 1982). Thus, it is possible that European Americans rate excited (vs. calm) faces as more affiliative because they experience *less negative affect* when they view excited (vs. calm) faces. This implies not only that European Americans should show less activity in the anterior insula and amygdala than Chinese when viewing excited (vs. calm) smiles, but also that these cultural differences in activity could be negatively associated with cultural differences in affiliative judgments of excited (vs. calm) smiles.

The present study

In previous research (Park et al. 2016), European Americans and Chinese viewed excited or calm faces and then rated those faces in terms of leadership or familiarity while undergoing functional magnetic resonance (FMRI) scanning. After scanning, participants viewed the same faces again and rated them in terms of affiliation,

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dominance, and competence. Months later, participants were shown pairs of excited and calm faces and asked to choose the one from each pair that they would like to see again. Among European Americans and Chinese, the greater VS activity participants showed in response to excited (vs. calm) faces while they were viewing the face but *before* they made their judgments of leadership and familiarity, the more likely they were to prefer the excited (vs. calm) faces months later. Therefore, we predicted that cultural differences in affiliative judgments would be similarly mediated by VS activity, or processes linked to reward and high arousal positive affect. Thus, we treated the other two mechanisms described above (identity/self-relevance and negative affect) as potential alternative accounts.

To test our prediction, we conducted a secondary analysis of data collected in the study described above (Park et al. 2016). Specifically, we examined brain activity when participants were beginning to make their leadership (and familiarity) judgments [i.e., 2 s after the period examined in Park et al. (2016)] and examined whether this was associated with social judgments of affiliation, dominance, and competence—none of which were analyzed in the previous study. We reasoned that while participants were making complex judgments of leadership in the scanner, they would also implicitly judge the target faces in terms of more basic traits including affiliation, dominance, and competence. Because this paper focuses on judgments of affiliation, dominance, and competence, we do not discuss the leadership or familiarity judgments further (although Park et al. 2016 provides greater detail).

Hypotheses

We predicted that: (1) European Americans would rate excited (vs. calm) faces as more affiliative than would Chinese, (2) European Americans would show greater ventral striatal (VS) activity in response to the excited (vs. calm) faces, compared with Chinese, and (3) cultural differences in affiliative judgments of the excited (vs. calm) faces would be mediated by cultural differences in VS activity in response to the excited (vs. calm) faces.

Methods

Participants

We conducted secondary analyses on a previously published dataset of 19 European American and 19 Chinese female university students (18–28 years old; Park et al. 2016). We recruited female participants only because previous studies found that cultural differences in ideal affect (Tsai et al. 2006) and affiliative judgments of excited vs. calm faces (Tsai et al. in press) were not modulated by participant gender, and we wanted to minimize heterogeneity within the cultural groups. European Americans were included in the study if they were born and raised in the United States, primarily spoke English, had parents who were born and raised in the

United States, and had grandparents who were born and raised in the United States or Western Europe. Chinese were included in the study if they were born and raised in China, Hong Kong, Taiwan or Singapore; moved to the United States or Canada after 18 years of age; lived in the United States for less than 5 years; primarily spoke Chinese; and had parents and grandparents who were born and raised in China, Hong Kong, Taiwan, or Singapore.

In addition to specific cultural criteria, participants met scanner compatibility criteria (right-handed, no neuropsychological symptoms, no medications). The participants were part of a larger sample of 22 European American and 27 Chinese as in Park et al. (2016), but data from 11 participants were excluded from final analyses because six participants showed excessive head movement (> 2 mm) from one scan to the next, three experienced software malfunctions, one missed responses on over 15% of the trials, and one experienced interruptions in the study protocol.

Facial rating task

We created 48 computer-generated faces that varied by race (White, Asian), sex (male, female), and expression (no smile, low intensity smile, moderate intensity smile, high intensity smile) using the FaceGen Modeller program (http://facegen.com) (See Supplementary Materials Sect. 1 for sample faces and FaceGen parameters).

As shown in Fig. 1, in the scanner, participants viewed each face for 2 s. Participants were then asked to rate how much of a leader or how familiar each face was, using a four-point scale ranging from 1 = *not at all* to 4 = *very* (4 s). Because each target face was rated twice, once for the leadership judgment, and once for the familiarity judgment, there were 96 trials in total. The presentation order of each target face and question type was randomized for each participant. Participants then were shown a jittered fixation point (2–6 s). The analyses in this paper focused on the 2 s when participants were just beginning to make their leadership and familiarity judgments marked as the “Early rating period” in Fig. 1. We focused on the first 2 s of the rating period in order to capture the time that we considered the most relevant to participants’ judgments about the targets, given that the average reaction time for making the leadership or familiarity judgment was just under 2 s (M = 1.83 s, SD = .71).

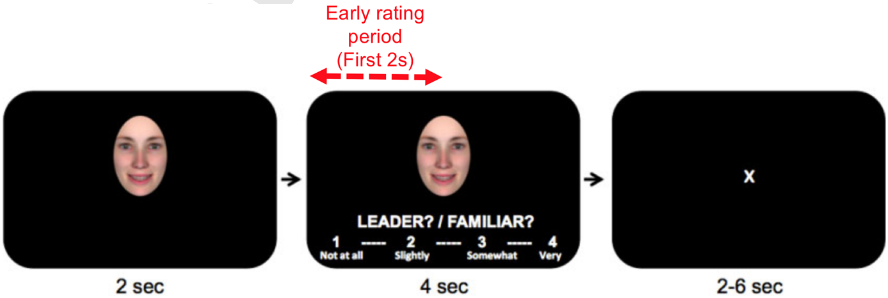

Fig. 1 Facial rating task trial structure (adapted from Park et al. 2016)

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Instruments

Ideal affect

To measure participants' ideal and actual affect, we administered the Affect Valuation Index (AVI; Tsai et al. 2006). Participants rated to what extent they actually feel different affective states (actual) and to what extent they would ideally like to feel different affective states (ideal) over the course of a typical week using a scale ranging from 1 = *never* to 5 = *all the time*. To capture all valence and arousal quadrants, participants rated 37 affective states (enthusiastic, dull, excited, sleepy, strong, sluggish, euphoric, fatigued, angry, idle, aroused, rested, astonished, quiet, surprised, still, passive, inactive, contemptuous, guilty, fearful, calm, hostile, peaceful, nervous, relaxed, stressed, disgusted, elated, lonely, content, sad, happy, unhappy, satisfied, ashamed, serene). To account for cultural differences in response styles (Chen et al. 1995), we ipsatized participants' ratings of each item (i.e., we subtracted the overall mean of all ideal affect items from each ideal affect item and then divided the difference by the overall standard deviation of all ideal affect items). We then calculated an ideal HAP score by averaging ipsatized ratings of ideal excited, elated, enthusiastic and euphoric items, and an ideal LAP score by averaging ipsatized ratings of ideal calm, peaceful, relaxed and serene items. We followed the same procedure for actual HAP and actual LAP. All Cronbach's alphas were greater than .63 (see Park et al. 2016 for specific alpha values).

Social judgments

After the scanning session, participants viewed the 48 target faces again and rated how friendly, intelligent, and assertive the target was, as well as how much they liked the target and how similar they felt to the target, along with other filler items, using a four-point scale, ranging from 1 = *Not at all* to 4 = *Very*. As in Park et al. (2016), we aggregated responses to "no smile" and "low intensity smile" faces to examine responses to "calm" expressions, and we aggregated responses to "moderate intensity smile" and "high intensity smile" faces to examine responses to "excited" expressions. Therefore, among the 48 faces, there were 8 types of targets that varied by expression (excited, calm), race (White, Asian), and sex (male, female) (e.g., White female excited target). We first averaged across the six faces of each type to create five social judgments (friendly, intelligent, assertive, liking, similarity) per type. Since previous findings indicated that target race and target sex do not modify the effect of ideal affect match (Park et al. 2016, 2017; Tsai et al. in press), we further averaged these social judgments across target race and target sex to maximize power, resulting in 5 social judgments for "calm" targets and 5 social judgments for "excited" targets.

Similar to Tsai et al. (in press), we created an affiliation aggregate by averaging friendliness, liking, and similarity judgments (α for excited faces = .85 for European Americans, .82 for Chinese; α for calm faces = .74 for European Americans, .66 for Chinese). Factor analyses supported the coherence of this aggregate (see Supplementary Materials, Sect. 2). Intelligence judgments were treated as an index of

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competence, and assertiveness judgments were treated as an index of dominance, as in previous work (Anderson and Kilduff 2009; Fiske et al. 2002; Tsai et al. in press).

Procedure

Upon arrival to the laboratory, participants practiced the Facial Rating Task with two faces (not shown during the subsequent scanning session) before they entered the scanner. Participants were then placed in a 3.0-T General Electric Discovery MR750 scanner outfitted with a 32-channel head coil, and underwent 96 trials of the facial rating task while their functional scans were acquired.

After the task, participants exited the scanner and completed the AVI along with other filler questionnaires. They then were asked to view the 48 target faces again and make the social judgments described above. Participants were debriefed and compensated for participating in the study.

fMRI data processing and analyses

We used Analysis of Functional Neural images (AFNI; 2011_12_21_1014 version) software (Cox 1996) for our analyses of the neural data. The first six scans before the task were dropped. With all other images, we conducted slice timing correction (using the first slice as reference), motion correction (using the 3rd volume as reference), spatial smoothing (with 4 mm full width at half maximum kernel), and normalization to average percent signal change and high-pass filtering [removing frequencies $< .01$ Hz as described in Wu et al. (2014)].

For the purpose of these secondary analyses, we used volume-of-interest (VOI) timecourse data from the original paper (see Supplementary Materials, Sect. 3 for post hoc whole-brain analyses and results), as in previous research (Genevsky and Knutson 2015; Kuhnen and Knutson 2005; Leotti and Delgado 2011; Wu et al. 2014; see Knutson and Bossaerts 2007 for review). Spherical VOIs (8 mm diameter) based on contrast maps reported in Park et al. (2016) were centered on MNI coordinates in the *bilateral ventral striatum* (Right VS: 13, 4, -7, Left VS: -22, 4, -3). We also extracted timecourse activity from the *medial prefrontal cortex* [MPFC; -7, 46, -8; coordinates from contrast maps in Park et al. (2016)], *bilateral insula* (Right insula: 36, 7, 0 Left insula: -42, 7, -3, coordinates from the contrast map with lenient threshold), and *bilateral amygdala* (± 23, -4, -18; coordinates from using AFNI atlas location). Percentage signal change data from each subject were averaged within each VOI, and then activity timecourse data were extracted for 20 s following the onset of each face presentation. As with the social judgment data described above, we aggregated time courses data in response to no smile and low-intensity smile faces to examine responses to "calm" expressions, and we aggregated time course data in response to moderate-intensity smile and high-intensity smile faces to examine responses to "excited" expressions. We found the same pattern of results when we grouped faces into two vs. four expressions (see Supplementary Materials, Sect. 4). To account for the hemodynamic response, measures of peak activity were lagged by 4 s and submitted to further analyses.

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Results

Cultural differences in ideal affect

As reported in Park et al. (2016), pairwise comparisons showed that Chinese participants wanted to feel LAP more than European Americans, $t(35) = -2.36$, 95% CI [−.51, −.04], $p = .024$. Moreover, Chinese participants valued LAP (M = 1.25, SE = .08) more than HAP (M = .75, SE = .09), $t(17) = -3.08$, 95% CI [−.84, −.16], $p = .007$ (Fig. 2). This specific Chinese sample did not differ from European Americans in their ideal HAP, $t(35) = .43$, 95% CI [−.20, .31], $p = .667$, although the means were in the direction of previous findings. Moreover, European Americans wanted to feel HAP (M = .80, SE = .09) and LAP (M = .97, SE = .08), $t(18) = -1.26$, 95% CI [−.46, .12], $p = .225$, to similar degrees. Given that our Chinese participants were recruited from the San Francisco Bay Area, they could represent a selective group that chose to live in the United States rather than their home country. Moreover, through acculturation, these Chinese might already value HAP to a similar degree as their European American peers.

Are there cultural differences in affiliative judgments of excited versus calm targets?

We conducted 2 Participant Culture (European Americans, Chinese) × 2 Target Expression (excited, calm) repeated-measure analyses of variance on each judgment (affiliation, competence, dominance). Participant Culture was treated as a between-subject factor, and Target Expression was treated as a within-subject factor. Since our directional hypotheses were based on previous research, we used one-tailed tests of significance to test the predicted directional hypotheses (i.e., European Americans would rate excited [vs. calm] faces as more affiliative than Chinese).

Affiliation

A significant main effect of Target Expression, $F(1, 36) = 20.60$, $p < .001$, partial eta-squared = .36, indicated that excited faces (M = 2.51, SE = .06) were rated as more affiliative than calm faces (M = 2.22, SE = .05), 95% CI [.16, .43]. However, this significant main effect was qualified by a marginally significant Participant Culture × Target Expression interaction, $F(1, 36) = 3.52$, $p = .069$, partial eta-

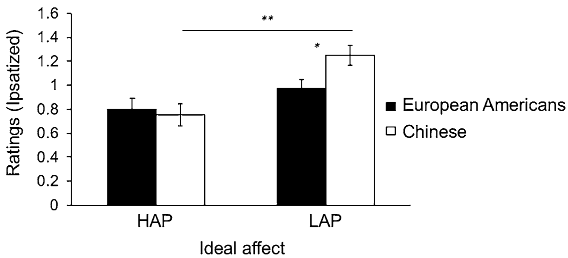

Fig. 2 Cultural differences in ideal affect (figure adapted from Park et al. 2016). HAP: high arousal positive states; LAP: low arousal positive states; **$p < .01$, *$p < .05$

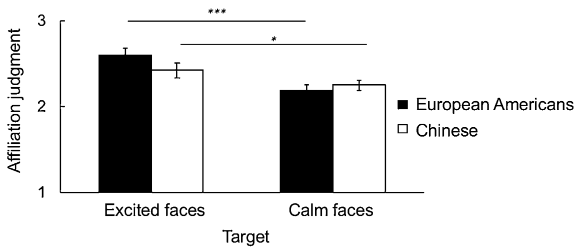

Fig. 3 Cultural differences in affiliation judgments. *one-tailed $p < .05$; ***one-tailed $p < .001$

squared = .09. Although this interaction was marginally significant, because we had specific predictions about cultural differences in the pairwise comparisons, we conducted the planned pairwise comparisons.

As shown in Fig. 3, these planned comparisons revealed that European Americans rated excited faces (M = 2.60, SE = .09) as significantly more affiliative than calm faces (M = 2.19, SE = .06), one-tailed $p < .001$, 95% CI [.23, .60]. Although Chinese also rated the excited faces as more affiliative than the calm faces (excited M = 2.42, SE = .09; calm M = 2.25, SE = .06, one-tailed $p = .034$, 95% CI [− .01, .36]), the magnitude of the difference was significantly smaller for Chinese than European Americans (European American M = .42, SE = .09; Chinese M = .17, SE = .09), $t(36) = 1.88$, one-tailed $p = .035$, 95% CI [− .02, .51]. Thus, our findings replicate those in Tsai et al. (in press). European Americans also rated excited faces as more affiliative than did Chinese, although this predicted difference was marginal, one-tailed $p = .075$, 95% CI [− .07, .43]. There were no cultural differences in the affiliation judgments of calm faces, one-tailed $p = .242$, 95% CI [− .25, .12].

Competence

A significant main effect of Participant Culture, $F(1,36) = 6.17$, $p = .018$, partial eta-squared = .15, indicated that European Americans (M = 2.83, SE = .07) rated the faces as overall more competent than Chinese did (M = 2.58, SE = .07), 95% CI [.05, .45]. A significant main effect of Target Expression, $F(1, 36) = 29.50$, $p < .001$, partial eta-squared = .45, additionally indicated that participants rated calm faces (M = 2.92, SE = .06) as more competent than excited faces (M = 2.49, SE = .07), 95% CI [− .59, − .27]. There was, however, no significant Participant Culture × Target Expression interaction, $F(1,36) = .93$, $p = .34$, partial eta-squared = .03.

Dominance

There was no significant main effect of Participant Culture, $F(1,36) = .40$, $p = .53$, partial eta-squared = .01, or Target Expression, $F(1,36) = .22$, $p = .641$, partial eta-squared = .01 for dominance judgments. However, there was an unpredicted significant Participant Culture × Target Expression interaction, $F(1,36) = 9.70$, $p = .004$, partial eta-squared = .21. This interaction suggested that European

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Americans rated excited targets (M = 2.70, SE = .10) as marginally more dominant than calm targets (M = 2.44, SE = .10), $p = .070$, 95% CI [− .02, .54], whereas Chinese rated calm targets (M = 2.68, SE = .10) as significantly more dominant than excited targets (M = 2.33, SE = .10), $p = .016$, 95% CI [− .63, − .07]. European Americans also rated excited targets as more dominant than Chinese did, $p = .014$, 95% CI [.08, .66], while Chinese rated calm targets as marginally more dominant than European Americans did, $p = .098$, 95% CI [− .53, .05].

In sum, consistent with Hypothesis 1, European Americans rated excited (vs. calm) targets as more affiliative than did Chinese. This pattern of differences, however, did not emerge for competence judgments. Surprisingly, European Americans also rated the excited (vs. calm) targets as more dominant than did Chinese.

Are there cultural differences in neural responses to excited (vs. calm) faces?

We submitted peak activity in the predicted regions of interest (VS) as well as the control regions (MPFC, anterior insula, amygdala) to 2 Participant Culture (European Americans, Chinese) × 2 Target Expression (excited, calm) mixed repeated measures ANOVA models, with Participant Culture as a between-subject factor and Target Expression as a within-subject factor. Since we had an a priori hypothesis about cultural differences in VS activity in response to excited (vs. calm) targets, we again used a one-tailed significance level for analyses that specifically tested this prediction.

Ventral striatum

There was a significant Target Expression main effect, $F(1,36) = 12.52$, $p = .001$, partial eta-squared = .26, indicating that participants showed greater VS activity in response to calm faces (M = .03, SE = .01) than excited faces (M = − .01, SE = .01), 95% CI [− 05, − .02]. However, as predicted, this effect was qualified by a marginal Participant Culture × Target Expression interaction effect, $F(1,36) = 3.53$, $p = .068$, partial eta-squared = .09. Although this interaction was marginally significant, because we had specific predictions about cultural differences in the pairwise comparisons, we conducted the planned pairwise comparisons.

While European Americans did not differentiate excited (M = − .01, SE = .02) faces from calm faces (M = .01, SE = .02), one-tailed $p = .124$, 95% CI [− .04, .01], Chinese showed greater VS activity in response to calm faces (M = .05, SE = .02) than excited faces (M = − .01, SE = .02), one-tailed $p < .001$, 95% CI [− .08, − .03] (Fig. 4). European Americans and Chinese did not significantly differ in VS activity in response to excited (one-tailed $p = .474$) or calm faces, although the latter approached significance (one-tailed $p = .097$). These results mirror the pattern of cultural differences in ideal affect in these samples, in that European Americans valued HAP and LAP to a similar degree; Chinese valued LAP more than HAP; and Chinese valued LAP more than European Americans did.

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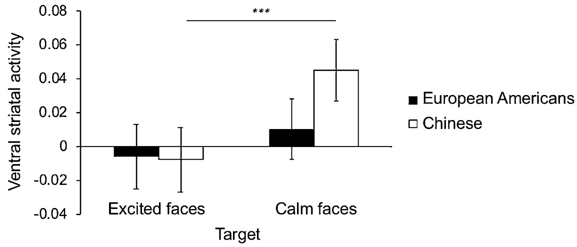

Fig. 4 Cultural differences in ventral striatal activity. ***one-tailed $p < .001$

Medial prefrontal cortex (MPFC)

An unexpected significant main effect of Target Expression $F(1,36) = 13.74$, $p = .001$, partial eta-squared = .28, suggested that participants showed greater MPFC activity in response to the calm faces (M = − .01, SE = .03) than to the excited faces (M = − .11, SE = .03), 95% CI [− .16, − .05]. However, the Participant Culture main effect and Participant Culture × Target Expression interaction effect were not significant, *p*s > .44.

Anterior insula

There was a significant Participant Culture × Target Expression interaction effect, $F(1,36) = 4.37$, $p = .044$, partial eta-squared = .11, indicating that European Americans showed lesser decreases in insula activity in response to the excited faces (M = − .06, SE = .01) than calm faces (M = − .09, SE = .02), $p = .126$, 95% CI [− .01, .06]. In contrast, Chinese showed lesser decreases in insula activity in response to the calm faces (M = − .06, SE = .02) than excited faces (M = − .08, SE = .01), $p = .173$, 95% CI [− .05, .01]. None of these differences, however, were significant. European Americans and Chinese also did not significantly differ in insula activity in response to excited faces ($p = .308$) or calm faces ($p = .211$).

Amygdala

There was no significant Participant Culture main effect, Target expression main effect, or Participant Culture × Target Expression interaction effect on amygdala activity, *p*s > .25.

In sum, consistent with Hypothesis 2, European Americans showed greater VS activity in response to excited (vs. calm) faces compared with Chinese. However, this difference was driven by the Chinese, whose VS activity was greater in response to calm vs. excited targets. In contrast, European Americans' VS activity did not differentiate between excited and calm targets. The pattern of these findings paralleled the ideal affect data.

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Do cultural differences in VS activity mediate cultural differences in affiliative judgments?

To test Hypothesis 3, we created three difference scores by subtracting participants' social judgments of calm targets from those of excited targets (affiliation [excited—calm], competence [excited—calm], dominance [excited—calm]), and four difference scores by subtracting participants' neural activity in response to the calm targets from that to the excited targets (VS [excited—calm]; MPFC [excited—calm], anterior insula [excited—calm], amygdala [excited—calm]). We then conducted indirect effect analyses (bootstrapped n = 10,000) using the "indirect" macro (Preacher and Hayes 2008). Again, we used one-tailed directional tests to test our prediction that cultural differences in affiliation judgments of excited (vs. calm) targets would be mediated by cultural differences in VS activity in response to excited (vs. calm) targets.

First, Participant Culture (+ 1 = EA, − 1 = CH) predicted VS activity (excited—calm), B = .02, SE = .01, ß = .30, t = 1.88, one-tailed p = .034, indicating that European Americans showed greater VS activity in response to the excited targets than to the calm targets relative to their Chinese counterparts (Fig. 5; path a). Second, VS activity (excited—calm) significantly predicted affiliative judgments (excited—calm), B = 2.20, SE = 1.07, ß = .33, t = 2.06, one-tailed p = .023 (path b). The greater VS activity participants showed in response to the excited vs. calm targets, the more affiliative they rated the excited vs. calm targets. Lastly, the effect of Participant Culture on affiliation judgments (excited—calm), B = .12, SE = .06, ß = .30, t = 1.88, one-tailed p = .034 (path c) decreased when VS activity (excited—calm) was entered in the model, B = .08, SE = .07, ß = .20, t = 1.25, one-tailed p = .11 (path c'), and the indirect effect through VS activity (excited—calm) reached significance, standardized effect = .10, SE = .06, 95% CI [.01, .29].

Cultural differences in affiliation judgments (excited—calm) were not mediated by MPFC, anterior insula, or amygdala activity. Moreover, competence and dominance judgments were not associated with activity in any of the brain areas examined (see Supplementary Materials Sect. 5 for indirect effects).

In sum, consistent with Hypothesis 3, cultural differences in affiliative judgments of excited (vs. calm) faces were mediated by cultural differences in VS activity.

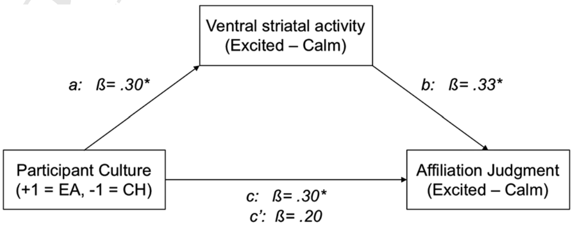

Fig. 5 Ventral striatal (VS) activity mediates cultural differences in affiliation judgments. We report standardized ß values and unstandardized culture codes (European American = + 1, Chinese = − 1) for ease of presentation. *one-tailed p < .05

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Discussion

As predicted, cultural differences in affiliative judgments of excited (vs. calm) targets were specifically mediated by differences in ventral striatal activity, which has been associated with reward processing and the experience of high arousal positive affect. These findings suggest that one reason European Americans may judge excited (vs. calm) targets as more affiliative than Chinese is that they anticipate greater reward from people who make those expressions. We found no neural evidence, however, that the observed cultural differences in affiliation judgments were related to activity in circuits associated with identity or self-relevance (i.e., MPFC) or to experiences of negative affect (i.e., anterior insula and amygdala).

Although our findings revealed cultural differences in responses to excited vs. calm targets, the specific cultural group that drove the differences varied by type of response. Cultural differences in affiliative judgments were driven by European Americans. Although both cultural groups rated excited targets as more affiliative than the calm ones, European Americans made a significantly greater distinction between the two than did Chinese. In contrast, cultural differences in ventral striatal activity were clearly driven by Chinese. Chinese showed greater VS activity in response to calm vs. excited targets, whereas European Americans did not clearly neurally differentiate between the two. Interestingly, the pattern of neural responses was similar to that of self-reported ideal affect: Chinese valued LAP more than HAP, whereas European Americans valued HAP and LAP to the same degree. The discrepancy between cultural differences in neural responses and affiliation judgments suggest that additional processes may occur in between when European Americans and Chinese initially view faces and when they subsequently judge how affiliative those faces are. Future studies are needed to assess the nature and dynamic flux of these processes.

As in previous reports, there were no cultural differences in competence judgments of excited (vs. calm) faces. However, cultural differences in dominance judgments did emerge. Although most of our studies have not observed such differences, we did see them in one study in which participants were asked to watch videos of excited, calm, and neutral job applicants, rate their affiliation, dominance, and competence, and then choose which applicant to hire for an internship (Tsai et al. in press, Study 3). In that study, European Americans rated excited (vs. calm) applicants as more affiliative and more dominant than did Chinese. In the present study, participants judged the faces in terms of leadership. Thus, it is possible that in the context of job hiring and leadership, dominance judgments are also related to cultural differences in ideal affect. Future research will need to systematically examine other contextual factors that might shape cultural differences in dominance judgments.

Previous studies have demonstrated that increases in ventral striatum activity are associated with feelings of positive arousal or excitement (for reviews, see Knutson and Greer 2008; Knutson et al. 2014). This might imply that Chinese somewhat paradoxically experience more excitement when perceiving calm (vs. excited) faces.

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However, no studies have linked VS activity with feelings of excitement in cultures that value calm states more. Thus, future studies might test whether perceiving calm faces is associated with feelings of excitement for Chinese.

Implications

These findings suggest that culture can shape activity in circuits deep in the brain. While some scholars have argued that culture should primarily influence symbolic and cognitive processes (D'Andrade 1981), our findings suggest that culture can also influence affective processes. Differentiating between these mechanisms may be particularly important when developing interventions to combat unconscious biases against or preferences toward specific targets in multicultural societies. For example, although being taught about unconscious biases related to race and sex significantly reduced them (Devine et al. 2012; Lepore and Brown 2002), more might be needed to reduce unconscious biases related to affect.

Study limitations

This study is limited in several ways. First, although neural responses were obtained while participants were making social judgments, these judgments were explicitly about leadership and familiarity. As mentioned above, our rationale was that participants would be making more basic judgments about affiliation, dominance, and competence as they assessed more complex traits such as leadership. Thus, we believe that the facial rating task implicitly elicited social judgments related to affiliation, dominance, and competence. Future studies, however, should examine whether our findings hold when neural responses are assessed while participants are explicitly making affiliative judgments in the scanner. Second, while we did not find evidence for mechanisms associated with identity or self-relevance, it is possible that our task did not adequately tap into those mechanisms. Tasks directly involving those mechanisms (e.g., having participants actively identify with the target) are needed in future research. Third, although previous studies showed that cultural differences in ideal affect and affiliation judgments did not vary as a function of judges' gender, future studies should examine whether male participants show similar ventral striatal responses as female participants. Fourth, as noted earlier, European Americans' ventral striatal activity did not differentiate between excited and calm faces, but they still rated excited faces as more affiliative than calm faces. Further studies are needed to examine what other factors might additionally contribute to affiliative judgments. Finally, while previously observed cultural differences in ideal LAP were replicated in this sample, those for ideal HAP were not, likely due to the select nature of the Chinese sample (i.e., international students living in the U.S.). Future research should examine whether the present findings generalize to Chinese living in Chinese (vs. U.S.) contexts.

Despite these limitations, our findings provide preliminary evidence that cultural differences in affiliative judgments of excited (vs. calm) targets are related in part to cultural differences in the rewarding impact of those targets. This study adds to the

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growing literature in cultural neuroscience by highlighting how affect mediates cultural differences in the social judgments of smiles.

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